SEP 18 1924

TELEPHONE ENGINEER

VOLUME 28 SEPTEMBER, 1924 NUMBER 9

A telephone manager writes: "Our subscribers like Strowger Automatic service so well and say so many complimentary things about it, that it is a pleasure to be in the telephone business."

Simplifying The Manager's Job

THE installation of Strowger Automatic telephone equipment does much more than render pleasing service to subscribers and furnish the stockholders with a steady profit on their investment. The influence of its efficiency touches every employe and every activity of the company using it.

The telephone manager, for instance, is no longer burdened with the annoying details of maintaining a large staff of employes, nor is he embarrassed by an undue number of service complaints. The time formerly spent in these ways he is now able to devote to constructive effort, such as getting new business, building goodwill and making his company and its activities well known among other business men. After all, isn't that a telephone manager's real job?

Progressive operating organizations all over the world are standardizing on Strowger Automatic equipment. When your company, Mr. Manager, falls in line, it will mean a bigger and better job for you.

Automatic Electric Company

Factory and General Offices: Chicago, Illinois

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International Automatic Telephone Company, Ltd ..... London
Automatic Telephone Mfg. Co., Ltd ..... Liverpool
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FOR REAL SERVICE

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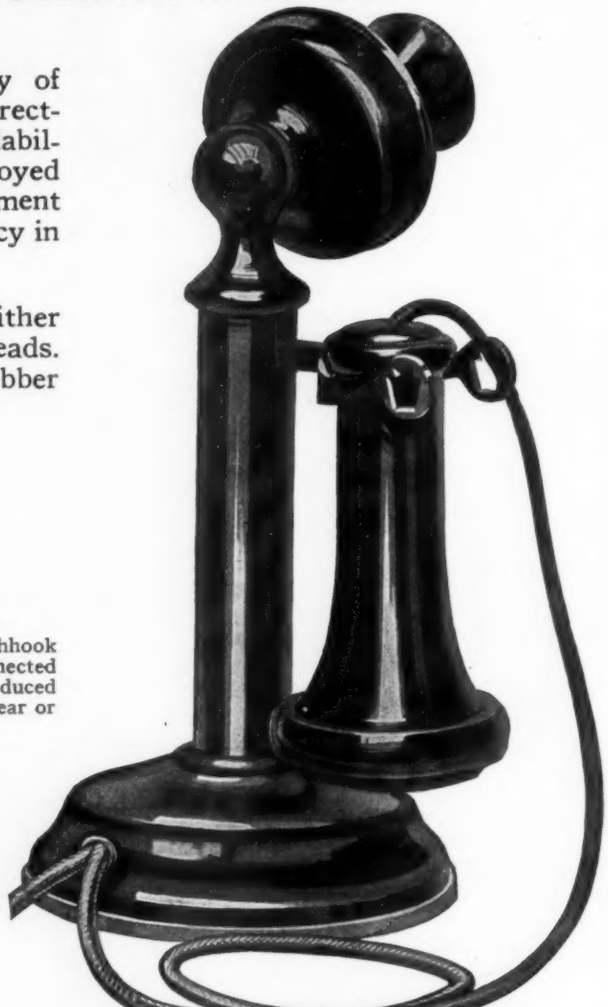
Stands are supplied with either solid or adjustable transmitter heads. Base is equipped with Burns Rubber Cushion.

IN THE STEM

Note the simplicity of the Switchhook construction and the direct connected cord terminals. Equipment is reduced to a minimum and all possible wear or trouble eliminated.



Secure satisfied subscribers by installing THESE "tested and proven" TELEPHONES.

Prices and detailed information furnished on full line of SWITCHBOARD and TELEPHONE equipment.

RADIO APPARATUS

Burns Loud Speakers and our Radio Head Telephones Have Proven exceptionally popular—They are built by telephone experts.

A stock of our standard equipment is carried in stock by a distributor in your territory

American Electric Company

CHICAGO, U. S. A.

FOR OVER 30 YEARS MAKER OF GOOD TELEPHONES

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A BROADENING MARKET FOR TELEPHONE SECURITIES

It seems that not everyone agrees with the idea expressed editorially in these columns that the present time is a good time for telephone financing. One of those who differs with us, criticising our editorial in a friendly way, said, "There may be plenty of money in the banks and money rates may be low, but if you try to borrow some of that money, you soon find out that the banks are holding it pretty closely." This may be true in certain localities, but even if it were generally true, it would not alter the fact that it is relatively easy at the present time to do permanent financing if a telephone company can make a proper financial showing.

That there is a broadening market for telephone securities is shown by reports of sales in various parts of the country. We have heard a great deal of bad business conditions in the northwestern states on account of low prices of farm products, yet during the first six months of the present year employes of the Northwestern Bell Telephone Co. acting as salesmen for A. T. and T. stock, placed stock with a par value of over $1,500,000 in the five states, Minnesota, Iowa, Nebraska and the Dakotas. In five southwestern states, Bell employees sold nearly two and a half millions.

Nor is this market confined to Bell securities. In Illinois, an issue of four hundred thousand dollars in first mortgage bonds of a new company taking over existing properties, was marketed through a Chicago banking house. Public Service Commission reports from all parts of the country indicate that smaller companies are issuing securities in amounts from fifty dollars upwards to many thousands. It may be assumed that a market for these securities is being found. Of course, these are all dividend or interest paying securities with an ample margin of safety for both principal and return. For others, there is no market and no market can ever be created.

DEMOCRATIC OWNERSHIP AND OPERATION OF PUBLIC UTILITIES.

In the year of a presidential campaign, we must always look for a recurrence of efforts to inject into the campaign such questions as government ownership and control of public utilities. It is interesting to note the statements in the platforms of the two old parties and of the recently formed third party on this subject. In brief, the Republican platform is opposed to "all attempts to put the government into business"; the Democratic platform does not discuss the matter, specifically, and the Progressive platform is content with general declarations which may be taken to favor government ownership within certain limits. All platforms may be said to favor the continuation of government regulation and control. In the case of the railroads, the Progressive party is the only one with a definite program of change, in that it calls for "public ownership of railroads, with democratic operation and with definite safeguards against bureaucratic control."

The last statement is of particular importance. It may be assumed that it was written with the idea of meeting the wishes of the four great railroad brotherhoods, if it was not actually dictated by them. It is far removed from the more radical policies of "government ownership and operation," advocated in certain quarters a few years ago. It indicates a realization of the evils of bureaucracy in the management of a public service and suggests the participation of all interested parties, including the worker and the user.

Outside of a few radicals and arm-chair economists, the principal support of government ownership of public utilities has come from labor circles. Observers of affairs within the labor movement have noted, in recent years, a change of attitude which is leading away from the old idea of a state which will own and control all means of livelihood, and toward a state in which private ownership will be retained but with a larger measure of co-operative management and co-operative division of returns. Labor has engaged in co-operative banking and in co-operative production in certain lines and more recently we have seen the "Glenwood Plan" in the operation of a railroad shop which is a kind of a co-partnership between the railroad and its employes. The ambition of the worker seems to have turned from the struggle for more wages and shorter hours to the hope for greater participation in management and in returns from the industry.

In the telephone field, there has

never been a real demand for government ownership, either from the workers or from the general public. The principle of democratic ownership and "democratic operation" probably has been carried farther in this than in any of the other great industries. A large percentage of telephone workers are owners of securities of the companies with which they engage their services. The number of telephone users who own shares in the telephone companies that serve them runs into the hundreds of thousands. The workers feel that they are represented in the management through their employes' associations and through the fact that executives have, in general, been promoted from the ranks. They are getting a share of the returns through dividends on their stock. The stockholder-subscribers likewise are participating in the returns, although they participate in management only through delegated authority. The management, however, cannot adopt policies that are adverse to the interests of the users to any great degree or for any long period, because such policies also would be adverse to the interests of a large proportion of the stockholders from whom authority is derived.

Altogether, it would seem that the telephone business already has made great strides toward popular ownership and democratic management and, in view of further progress in both that is taking place, rapidly, the spectre of government ownership here ultimately should be laid for all time.

THE CONVENTION YEAR BEGINS

If there is any time that may be considered to be the beginning of the telephone convention year it is the early autumn. To the Hoosier telephone men falls the honor of opening the season, and the Indiana convention will be in session in the middle of September. In October comes the national convention of the United States Independent Telephone Association and the meetings of the Telephone Pioneers' associations. Illinois follows in November and then comes the round of various states until the activities of the summer season bring the year to a close. Attendance at conventions during the past year has been large and the programs have been of increasing value to those who attend. From all appearances the coming year will be another big convention year.

THE FASCINATING GAME OF BUDGET

The telephone manager who has not engaged in the fascinating game of making a budget of his business and of checking performance to see how near to the estimates he can come has missed one of the most enjoyable parts of the job of managing a business. If he has had no budget or if his budget is incomplete, the article by Mr. Brookman in this issue will give him all the information necessary to make a complete budget. Now is a good time to commence collecting the information upon which to base the 1925 budget.

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PUBLICITY TECHNIQUE

There is more to news publicity of utility companies than sending newspapers pretty little arrays of words. The merit of delicate technique necessary in supplying the utility side of a case to the newspapers for publication is evident in a recent editorial in Editor and Publisher, one of the foremost journals of the newspaper craft.

Editor and Publisher comments editorially on the case of a self-appointed champion of the "common peepul" in a utility rate case. The moral, so far as one can be determined, of this case, is to stick to the pertinent facts, and stay away from any out-and-out attempt to bring pressure to bear on the commissions through publicity.

The editorial comment in part:

"The pious nonsense concerning 'trial by newspaper' was classically shown up by an incident of the week in New York. The Pennsylvania Railroad Company, owning and controlling the Long Island Railroad, recently notified the thousands of Long Island commuters of a decision to boost fares 20 per cent. Public hearings were begun by the Transit Commission. The railroad was well represented by high-paid lawyers and press agents. The unorganized commuting public found a champion in the person of Maurice Hotchner, a lawyer, who took, without compensation, leadership of a fight against the rate increase.

"Mr. Hotchner made his findings public through the press. Ah, trial by newspaper! The volunteer lawyer on Wednesday came before the Transit Commission to proceed with his case and found a hot rebuke awaiting him. The Transit Commission indignantly denounced him for having given his evidence to the newspapers. The dignity of that body had been assailed. The charge was that the lawyer had committed a gross breach of professional conduct."

A Telephone Budget System

A Budget System Is a Necessity in Modern Business— A Prominent Telephone Official Tells How the Budget Is Prepared and Applied to the Telephone Business

By FRANK J. BROOKMAN*

There are few people this day and age who are not familiar with the word "budget." In fact, a great many apply the "budget" plan to the conduct of their household and family finances.

The annual budget as applied to our business does not greatly differ, except in scope and detail, from a household budget. In its final analysis our budget is a complete financial statement of expected performance of the company covering all of its operations during a given period.

The question may well be asked, "Why is it necessary to have a budget?" It is not necessary, neither is it necessary to have a compass to sail a ship, but the most competent navigator, without compass and charts, may sail miles out of his course or go on the rocks before arriving at his destination.

Utility Companies Must Plan Future

To serve a growing community economically a public utility must work today according to some definite plan which also anticipates the tomorrows to come. Big companies plan for periods running from ten to twenty years into the future. The plan may be corrected to meet unforeseen conditions or extended further into the future but generally speaking it is based upon a forecast of the conditions predetermined as accurately as possible.

While it is essential that a telephone company plan the general layout of its plant to conform to future requirements it need not build except to keep pace with the natural growth of the business.

Each year's building program is determined by the estimated requirements and does not or at least should not exceed certain economical limits.

The company's budget not only describes the physical projects necessary to accommodate the growth of the business but shows the costs in dollars and their effect on the accounts as a whole.

In its complete form it shows the expected growth; the plant required to accommodate this growth; replacements to be made during the year; the expected effect on the revenues and expenses, and it must show such net earnings as will satisfy the officers and board of directors that the plans proposed are sound and that the expenditure of capital funds is warranted.

It provides an analysis of capital requirements and capital resources and shows in its final result the amount of capital funds which must be obtained from outside sources to finance the proposed increase in the company's plant investment.

Properly made up the budget presents a complete and concise summary of the essential facts which the officers and board of directors need in order to be able to pass upon the program proposed for the coming year, and to analyze the financial problem, if any, to be met.

With the budget approved and in hand the responsible executives are provided with statements of expected performance with which to measure and compare actual working results and by which to steer the company's ship safely on its charted course. In other words, instead of working aimlessly from day to day trying to keep up with a growing business, the executives are co-ordinating the work of departments and intelligently directing the affairs of the company according to a carefully prepared plan.

The budget plan once put into effect becomes an interesting and absorbing game. It not only supplies a medium through which to test the judgment of each and every executive but it demands more intelligent thinking and planning in the administration of every department than could possibly be otherwise obtained. A budget in its simplest form is a benefit because it provides a plan of procedure calculated to produce a predetermined result, which would seem to be only ordinary common sense.

Steps in Preparing the Budget

Now how do we go about the preparation of a budget? This is not as difficult as it may seem.

Before the budget proper can be prepared there must be assumed a general line of procedure to follow. For convenience this can be called the general policy. This will be influenced by the company's present financial status; by the expected economic conditions; by the company's ability to raise capital funds; the cost of money; the limits of performance of the organization, etc.

After the general policy is determined the commercial forces prepare an estimate in conformity with the policy, of the expected public demand for toll and exchange service. This estimate or forecast must be conscientiously prepared to show the classes of service, the localities affected and the expected revenue to be gained.

The traffic department then prepares an estimate of its requirements in the way of additional switchboard facilities, in order to be able to handle the local and toll traffic, based upon the commercial department's forecast of increased business.

The plant and engineering departments make a general survey of the

Frank J. Brookman, vice-president of the Rochester Telephone corporation of Rochester, N. Y., began his telephone career in 1902 as a clerk in the office of the treasurer of the Central New York Telephone and Telegraph company at Utica, N. Y. He later became bookkeeper and auditor of the Utica Home Telephone company. In 1910 he became auditor of the Otsego and Delaware Telephone company and in 1913 moved to Plattsburgh, N. Y., where he became auditor of the newly organized Mountain Home Telephone company. In March, 1920, he became general auditor of the Rochester Telephone company, and when that company took over the Rochester properties of the New York Telephone company he was appointed general auditor of the Rochester Telephone Corporation. During the past year he was advanced to the position of vice president. Mr. Brookman's long experience in the accounting end of the telephone business qualifies him to speak with authority in all matters of accounting and financial management.

*Paper before Upstate Telephone Convention of New York.

outside facilities and estimate the additional circuits and associated plant required to supply the expected demand for service as forecast by the commercial department.

When this is finally determined the engineers make up a statement which summarizes the contemplated program for the coming year. This statement is detailed by projects and shows in dollars the plant additions expected to be uncompleted at the end of the current year and, therefore, to be carried over into the coming year; the additional new plant required for the coming year; the estimated book value of plant to be retired; the final net additions to the plant and equipment accounts; the salvage expected to be realized; estimated costs of removing old plant and the estimated net charge to the reserve accounts. It also shows the estimated cost of extraordinary repairs and the expected charges on account of wiring loss and gain.

Accompanying this financial statement is a statement in narrative form which describes each project in considerable detail. It explains the reason for doing the work, why it should be done during the coming year and in general ties it up with the company's general plan of development.

Each department is called upon to prepare an estimate of its expense for the coming year. The department heads are assisted by the accounting department and all factors affecting past and future performance are carefully weighed so that the estimates should compare very closely with the results of actual performance.

Final Budget Includes Nine Statements

The complete data are finally reviewed by the general manager and then forwarded to the accounting department where they are co-ordinated and incorporated with the final statements prepared by that department.

These final statements are:

1. Station report by exchanges showing number connected and disconnected during current year with unexpired portion of year estimated; total stations in service at end of current year and forecast of stations to be connected and disconnected during the coming year with expected number in service at the end of the year.

2. Narrative describing additions to plant under new projects.

3. Statement of uncompleted projects to be carried over from current year and effect on the accounts.

4. Statement of new projects contemplated and effect on the accounts.

5. Statement showing proposed additions and retirements of general equipment and effect on the accounts.

6. Summary of proposed additions and retirements of fixed capital showing effect on the accounts during the coming year.

7. A complete statement of revenues and expenses including non-operating revenues, non-operating revenue deductions and income deductions, in fact a complete profit and loss statement for the current year, with the unexpired portion of the year estimated, compared with a forecast of like items for the coming year.

8. A comparative balance sheet showing the expected balance in the accounts at the end of the current year and at the end of the coming year with the resulting increases and decreases.

9. An analysis of the balance sheet changes showing the expected capital requirements and capital resources and the amount of capital funds to be obtained from outside sources.

From the financial statements described there are some interesting statistical data prepared and chiefly among these is a statement showing the average rate of return in the past and the expected rate in the future. This in fact is the meat in the nut and will show whether the program defined in the budget will be profitable or unprofitable.

While statements in the budget may tell their own story it is essential that they be accompanied by a summary in narrative which gives a comprehensive and concise picture of the whole program and should include a definite recommendation to the board of directors.

This narrative is in some respects a brief supporting the budget as submitted, therefore, the recommendation should properly be that the board approve the budget in respect to the general program and new financing required, subject of course to the regular review and approval of the specific jobs or estimates as they are submitted during the year.

Performance Is Checked by Monthly Report

In connection with the budget system there should be some form of monthly report by which the responsible executives can check actual performance with the budget estimate. It may be that the financing of the plant extensions is dependent upon the net earnings and it is absolutely necessary that the results forecast in the budget be accomplished in which case a comprehensive monthly report will be very beneficial in the control of expenses.

For our company we have worked out a form of comparative statement which is arranged in columnar form and shows under the various titles the operating revenues, operating expenses and income accounts. This statement compares actual performance with the budget estimate giving the amount and per cent of variation for the current month and for the full period elapsed since the first of the year.

With this statement in hand our department heads and other executives are able to follow actual performance very closely and to a great extent control the activities of their respective departments, so that any great variations in one month may be overcome in the next or future months, and in this way produce the required net result. We believe that these statements will be very valuable in forecasting expenses for the future budgets because they will be studied and analyzed from month to month and department heads will become more familiar with the details pertaining to their departments, and therefore enabled to better forecast the items in future years.

In addition to the comparative statement of operating results, we believe there should be a similar statement of plant changes or net additions to fixed capital. While we are not using such a statement in our company at the present time we feel that it is necessary and expect to put it into effect as soon as possible.

There is another problem in connection with the administration of a budget plan which to my mind is the most complicated of all, and that is a proper scheme for charting monthly financial requirements. A forecast by months of capital expenditures is much more difficult than the forecast of operating expenses because to a great extent we are dependent on suppliers and contractors to deliver materials and equipment or to complete structures according to schedule dates. However, the financial officer must have information which will enable him to have sufficient amounts of available cash on hand when required to meet contractor's or supplier's bills. This, of course, becomes more important with the size of the company, because errors of poor judgment may mean large amounts of capital funds lying idle or producing only a small return. Of course it is assumed that the treasurer has provided for the regular fixed charges such as taxes, bond interest and dividends, but unless he is well advised as to probable due dates of bills covering large capital additions there is something lacking in the general scheme.

I have stated before in this article that the budget is a complete financial statement of expected performance of the company covering all of its operations during a given period. I have also stated that to obtain the estimated results the work of the various departments must be co-ordinated.

Concrete Poles Call for Care

Features of Concrete Poles Engage Attention of Telephone Men — Proper Pole Making No Simple Job — Telephone Wire Data — Specifications and Use

By P. KERR HIGGINS

Concrete in Telephone Work

In a previous article, the writer discussed in an informal way, the possible use of concrete poles and explained some of the features of their use. It appears that several readers are very much interested in this question and desire more information as to the advantages of concrete poles in telephone work and also a formula for concrete mixture.

Among the advantages of concrete poles are the following:

Cement material and factories are now to be found in almost every State and Territory in the Union. Concrete is proof against decay, fire, heat, water, woodpeckers, insects, fungus growths, cribbing horses, sign tackers, and in many cases against runaway autos. It is also, when reinforced, lightning proof and to a great extent fool proof. Concrete poles are also straight and sightly and are said to be better in twenty years after being set. In the holding of downward strains, concrete cannot be excelled even by white oak poles. However, on account of their weight, transportation and setting is much more expensive.

The following information was received a few years ago, while the writer was studying this subject, and it is believed that it may be of use to those interested.

Transportation and Setting

Concrete poles cannot be treated in all respects like wooden poles. They do not have to be gained nor need they be roofed except for appearance's sake. Being heavier than wood, weighing about 100 pounds to the cubic foot, they can not be piled on an ordinary wagon nor set up with pikes. The poles must, therefore, be set by means of a swinging gin pole, preferably one that can be attached to a truck that will both load the poles and swing them into the hole, guide ropes being largely relied upon to straighten the pole up when it is once in the hole. In this connection I should also like to suggest another idea. We have too long relied upon the old-fashioned bar, shovel and spoon in digging holes when machine augurs will do it much better and more rapidly. This is possible with concrete poles, because the butts will be of uniform size, so that it will not be necessary as in the case of wooden poles to make allowance for crooked and unwieldy butts and make holes large enough for cyclone cellars in order to have room for the line up."

Concrete Mixtures and Treatment

"Concrete is composed of Portland cement, sand, and rock, gravel or slag. The cement is used in varying proportions according to the kind and size of the other ingredients and the character of the concrete desired. In reinforced structures, steel rods are added in order to give greater tensile strength and elasticity. The stone or gravel, as well as the sand, should be free from clay or other earth mixtures, so that it is often necessary to specify washed sand and gravel. In poles, only sand, small gravel or finely crushed stone known as "chat" need to be considered.

The proportions of sand, chat and cement should be such that all spaces are filled and every particle of sand and stone well covered with a cement coating. There is no advantage in increasing the amount of cement beyond this, as even a thin coating of cement on every particle causes it to adhere strongly to its neighbor, and the mass can be made no stronger by increasing the proportion of cement.

In case sand only is used, a proportion of one part cement and four parts sand makes the strongest possible mixture. Where chat is obtainable the following formula used by one company making concrete poles has been found thoroughly reliable:

1 sack cement (100 lbs.)
2 wheelbarrows chat
3 wheelbarrows sand.

This makes one sack of cement extend to about six times its original bulk. Other formulas are sometimes given, but the above two will be the only ones to be considered for pole use.

Quick Handling Necessary

"Unless the handling of cement is well understood it is better to employ some thoroughly competent cement man, for in every case where good cement mixtures have proven unsatisfactory it can be traced to ignorance of its qualities, or improper manipulation.

There are two methods of applying water to cement which produce what are commonly called 'wet' or 'dry' mixtures and methods of treatment are not exactly the same. In the wet method enough water is added to make a mixture about the consistency of mortar. There should not be too much water as, in that case, the cement will float to the top while the sand and chat settle to the bottom, which will result in weak spots in the finished product. The sand, chat and cement should be thoroughly mixed while dry either by being turned several times with shovels or in a mixing machine. When well mixed, water should be added and the mixture placed in the mould or form as rapidly as possible, as cement begins to crystallize, or set, within ten minutes. If it begins to set before it is poured into the mould it cannot be used and the batch will have to be thrown away. Once in the mould it should not be disturbed until it has hardened.

The so-called dry mixture contains just enough water sprinkled on to hold it together; it does not require such swift handling as the wet mortar, but at the same time it should not lay around long. It is used a great deal in building blocks and in those forms where the mould is taken down immediately. The difference in wet and dry may be summarized as follows:

1. The wet mixture crystallizes more quickly and makes a harder concrete.

The dry mixture sets more slowly and hardens only after several hours.

2. Wet concrete should be left for at least one hour before the form is disturbed.

The dry mixture moulds may be taken apart immediately.

3. The wet form is quite well cured within two or three days.

The dry mixture should be left for at least thirty days.

Some engineers insist that all cement structures should cure for at least thirty days before using in order to prevent cracking and possible accidents. While poles as well as building blocks have been moulded one day and used the next, the practice is unsafe. Cement concrete hardens continually for quite a long time and is much harder at the end of one year than it is even after thirty days' curing.

Whether wet or dry mixtures are

used, however, they should not be exposed to the sun while curing, and should be kept damp while curing by wetting with a hose occasionally, for, if cement dries too quickly it will not attain its full strength. Keep it under a shed, tarpaulin or even tarred paper, but don't let the sun reach it before three days."

Pertaining to Reinforcement

"Concrete columns will stand an immense downward pressure, but under the stresses of expansion and contraction there is a tendency to crack. In order to overcome this tendency and permit of greater elasticity iron rods should be placed through them at regular intervals. Concrete will cling to plain, clean iron as firmly as to the sand and chat composing the mixture; should the rods be rusty you have, of course, only the holding strength of the rust coating. It will also cling to wood in the same manner, provided the wood has been well dampened, but wood shrinks in drying and its holding power cannot be relied upon. With iron, however, the case is different. As iron and cement have the same coefficient of expansion, there is never any deterioration of its holding power. The best size of rod to use in pole construction is about one-fourth inch chamfered plain steel without any galvanizing or paint upon it—as the concrete will not adhere so well to zinc which forms the coating of galvanized wire. These rods should be drawn tightly from end to end and tied together with wire at intervals of four or five feet in order to strengthen their holding power as well as prevent spreading while the concrete is being poured. Four of these rods are enough for any pole up to twenty-five feet in length and their number increased in the larger sizes up to say ten in a forty-five foot pole, but the extra rods need not be extended all the way to the top, but spliced onto the others at from one-half to two-thirds of the way up from the bottom. The rods at the bottom end may be bent around the bottom of the pole—thus grounding them—while those at the top may be cut off and the top of the pole afterwards rounded off with a trowelful of cement mortar. As each quarter inch rod has a breaking strain of approximately 4,000 pounds, it will be seen that when buried in concrete that adheres firmly, four rods will constitute a pretty strong column, especially when they are all bound together with wire. Iron buried in closely tamped concrete does not rust very much, as the concrete keeps the air from circulating around it, so that for these rods it is safe to estimate at least fifty years of life and perhaps more, by which time we may have some system entirely different. It should not be forgotten that cement adheres to iron only when the iron has been wetted, which is necessary in dry mixtures."

As Regards Forms

"In making forms for pole construction rather heavy planking is required if wood is used. This plank should be planed smooth with no rough spots or splintered projections. It should be filled with oil and when set up should be well greased on the inside to prevent the cement from adhering to the sides.

When desired, holes for the arm bolts as well as the through bolts for braces can be formed by placing a straight five-eighth inch rod where required. Should it be necessary to insert steps, holes can be bored in the side of the form and round bolts inserted the desired distance. When the form is taken down these bolts must be withdrawn, but steps can be put in when the concrete has set, with a little thin cement mortar which will harden and hold them in place.

When steps are not used poles must be climbed with a ladder or a sling."

Wire for Telephone Lines

In general practice and in accounting aerial wire is understood to include insulators, sleeves, wires of all kinds and other material used in attaching such wires to insulators, together with drop wires leading from the overhead plant or cable to the point of connection with the inside wires. In accounting the division between toll and exchange aerial wire is frequently made.

As important as the telephone instruments and other apparatus may be, a little consideration will make clear to us that the telephone lines connecting the subscribers to the exchange are of equal importance. Perhaps no other part of the telephone plant is more grossly abused and more carelessly handled than the telephone line. Especially is this true in magneto or local battery systems, as carelessness and lack of consideration both in construction and in maintenance are not noticed so quickly and hence are frequently ignored until transmission is impossible. It is reasonable to estimate that seventy-five per cent of the plant is in the distribution system composed of cables and wires. The exchange open wire plant should be kept down to the lowest point possible and cables used wherever economical and practical to do so.

Wire for telephone purposes must have good conductivity, possess great tensile strength, have as little weight as possible, and be low in cost. Many kinds of metal and combinations of different metal are used, copper being pre-eminently necessary where the lines are long or a high standard of transmission is necessary, or where rapid detoriation from chemical or other causes are likely. In rural work iron takes a leading place.

Manufacture of Copper Wire.

On account of the importance of copper wire in the telephone plant, an account of the method of manufacture may be of interest. The following is a description of one method of making copper wire: "The copper is received from the smelting works in the form of wire bars which are approximately fifty-four inches long, with an average diameter of three and three-quarters inches, and weighing about two hundred pounds each. The first operation is to put the bars into what is termed a 'continuous furnace,' the bars going in at one end and being taken out at the other. In passing through the furnace they are heated to about 950° C at the rate of about two bars per minute.

The heated bars are then put through a series of grooved rolls. Each succeeding groove being smaller, a reduction of the three and three-quarter inch bar to a cylinder having a diameter of 5/16 in. results. They are now called rods and taken up on a reel in the form of a coil about thirty inches in diameter. The coils are taken from the hot rolling department after they are cold. They are then plunged into a bath of sulphuric acid and water for the purpose of removing whatever oxide may have formed in the hot rolling operation. After being left about twenty minutes in this solution and the oxide removed, they are thoroughly washed with clean water at a high pressure, then immersed in a vat containing tallow and soap. The rods are now ready for the drawing process. The rods are drawn through what is commonly known as a 'continuous wire drawing machine.' After passing through several dies, each one reducing the diameter and hardening the wire thus forming a skin, it is finally drawn around a block to the finished diameter or size. This process of reduction, say from a No. 1 to a No. 10 wire gauge is known as 'nine numbers hard' and gives the wire the greatest amount of tensile strength possible and yet preserve its elasticity. In the smaller sizes of wire, very expensive diamond dies are used.

Commercial copper in its soft state has a tensile strength of about twenty-eight thousand pounds per square inch, with an elongation of about thirty-six per cent. The cold drawing process increases the tensile strength by each number drawn and also reduces the elongation. When the copper wire is drawn eleven numbers hard, the tensile strength is about sixty-four thousand pounds per square inch and the

elongation reduced to one per cent. The wire is now carefully inspected and tested for elongation, torsion, conductivity and tensile strength. It is then carefully wrapped with burlap in suitable coils and is ready for transportation."

Tests for Copper Wire

The following tests are usually made in determining the quality and standard of copper wire.

Twist Tests.—The wire is frequently required to permit twisting through a stated number of revolutions before breaking. This test is not recommended for the reason that the results may be influenced by temperature, speed of rotation, method of gripping, etc., which renders the results of the test doubtful. When used, the specification requires the wire to stand 35 twists in a 6-inch length.

Wrap Tests.—It is obvious that the making of a test of this kind, that is wrapping a wire around another wire of its own diameter, unwrapping and then rewrapping again, is exceedingly difficult. This wrapping tends to harden the wire still more and hence it is almost impossible to straighten out the wire, let alone recoil it in the opposite direction. For this reason this test is not recommended.

Elasticity.—The only way in which the elastic limit of hard wire may be determined is by the actual plotting of the elastic curve from extensometer reading. Such a test can only be made in a laboratory.

Elongation.—Elongation test lengths vary from eight to sixty inches. Elongation has been specified in various ways as, for instance, the permanent increase in the length of the wire, measured between bench marks placed on the wire before fracture; or as the elongation measured between the jaws of a testing machine, which are adjusted to grip the wire with a certain definite free length, or in various other ways. The specification most commonly used requires 0.8% in five feet.

Conductivity.—Electric conductivity is usually expressed as a percentage on the Matthiessen basis. Since this basis was established the methods of refining copper have been greatly improved, hence it is not uncommon to find copper of over 100% conductivity on this basis.

Resistivity.—This is expressed in a number of different ways, all being equivalent to the resistance of some unit of cross-section, this unit being expressed either in linear dimensions or as a combination of weight and dimensions.

The following table, while not absolutel accurate, is in common use in making tests of copper wire:

	N. B. S. Ga. No. 12.	No. 14.
Diameter in inches	.104	.080
Elongation	.9	.8
Twists in six inches	40	35
Bends on itself	3½	3
Weight per mile, pounds	175	110
Resistance per mile	4.8	7.92
Breaking strain	555	350

Dr. Matthiessen made exhaustive studies of this metal, both of pure annealed copper wire and of hard drawn copper wire. The result of his investigation proved the former to have a resistance of 13.39 ohms per mile, the wire being 1/16 of an inch in diameter at 60° F. He also determined the conductivity of hard drawn copper wire. From these samples he determined that the resistance of hard copper wire was 1.0226 times the resistance of pure annealed wire. These tests gave rise to the Matthiessen standard of pure annealed copper wire, namely, 9.95 ohms per mil-foot at the temperature of melting ice or 809.3 pounds per mile ohm. By mil-foot is meant the resistance of a wire one foot long and 1/1000 of an inch in diameter. By mile-ohm is meant the weight in pounds of a wire one mile long and having sufficient cross-section to have resistance of one ohm.

Some Facts About Wire Gauges

When considering copper wire it is a good practice to express its size in mils or thousandths of an inch, rather than in gauge numbers. There are two gauges in common use and confusion sometimes results from the use of the numbers. The Brown and Sharpe gauge, sometimes called the American Wire gauge, is in common use in this country for copper wire, but the new British standard (N.B.S.) is also used. No. 10 B. & S. ga. is approximately the same as No. 12 N. B. S. ga. and No. 12 B. & S. ga. is approximately the same as No. 14 N. B. S. ga.

Table I shows the various wire gauges in decimal parts of an inch.

Since the B. & S. gauge is most commonly used for copper wire by Independent companies, a few facts regarding the wires drawn to this gauge may be noted:

A wire which is three gauges larger than another wire has half the resistance, twice the weight and twice the area. A wire which is ten sizes larger than another wire has one-tenth the resistance, ten times the weight and ten times the area. No. 10 wire is 0.102 in. in diameter; has an area of 10,380 circular mils; has a resistance of one ohm per thousand feet at 68° F. and weighs 31.4 pounds per thousand feet. The relative values of the diameter of alternate sizes of wire are: .50, .63, .80, 1.00, 1.25, 1.60, 2.00. To find weight drop ciphers from the number of circular mils and multiply by the weight of No. 10 wire. To find the resistance drop one cipher from the number of circular mils and the result is the number of feet per ohm. It is also noted that copper equals one and one-seventh times the weight of iron wire of the same gauge.

TABLE NO. 1, SHOWING DIFFERENCE BETWEEN WIRE GAUGES IN DECIMAL PARTS OF AN INCH.

No. of Wire Gauge.	American or Brown & Sharpe.	Birmingham or Stubs.	New British.
000000	.....	....	....
00000	.....	....	....
0000	.46	.454	.4
000	.40964	.425	.372
00	.3648	.38	.348
0	.32495	.34	.324
1	.2893	.3	.3
2	.25763	.284	.276
3	.22942	.259	.252
4	.20431	.238	.232
5	.18194	.22	.212
6	.16202	.203	.192
7	.14428	.18	.176
8	.12849	.165	.16
9	.11443	.148	.144
10	.10189	.134	.128
11	.090742	.12	.116
12	.080808	.109	.104
13	.071961	.095	.092
14	.064084	.083	.08
15	.057068	.072	.072
16	.05082	.065	.064
17	.045257	.058	.056
18	.040303	.049	.048
19	.03589	.042	.04
20	.031961	.035	.036
21	.028462	.032	.032
22	.025347	.028	.028
23	.022571	.025	.024
24	.0201	.022	.022
25	.0179	.02	.02
26	.01594	.018	.018
27	.014195	.016	.0164
28	.012641	.014	.0148
29	.011257	.013	.0136
30	.010025	.012	.0124
31	.008928	.01	.0116
32	.00795	.009	.0108
33	.00708	.008	.01
34	.006304	.007	.0092
35	.005614	.005	.0084
36	.005	.004	.0076
37	.004453	....	.0068
38	.003965	....	.006
39	.003531	....	.0052
40	.003144	....	.0048

The following table, No. 2, compiled by C. F. Scott, may also be helpful in trying to remember constants similar to the ones given above:

Size.	Ohms.
No. 1	0.125
No. 4	0.25
No. 7	0.5
No. 10	1
No. 13	2
No. 16	4
No. 19	8
No. 22	16
No. 25	32
No. 11	1.25
No. 14	2.5
No. 17	5
No. 20	10
No. 23	20
No. 26	40
No. 29	80
No. 32	160
No. 35	320
No. 0000	0.05
No. 0	0.1
No. 3	0.2
No. 6	0.4
No. 9	0.8
No. 12	1.6
No. 15	3.2

Comparison of Copper and Iron Wire

The comparative properties of No. 12 N. B. S. gauge wire and iron wire are given in Table No. 3 below. I believe they are the results of tests made under the supervision of Mr. Doolittle, the inventor of hard drawn copper wire and chief engineer emeritus of the A. T. & T. Company:

No. 12 N. B. S.	Diameter in Mills.	Resistance per Wire Mile 68° F. Ohms.	Inductance per Mile Pair henries.	Effective Resistance per Wire Mile Ohms.	Electro Static Capacity per Pair Mile Micro microfarods.	Miles equal to 1 Mile Hard Drawn Copper for Telephone Transmission.
Soft copper	104	5.1	3.66	5.1	8220	1.02
Hard drawn copper	104	5.2	3.66	5.2	8220	1.00
Iron B. B.	104	36.0	18.00	47.0	8220	0.26

No. 12 N. B. S.	Diameter in Mills.	Weight per Wire Mile, lbs.	Tensile Strength in Pounds.	Torsion in 6 Inches.	Elongation, per cent.
Soft copper	104	173	290	50–75	40.
Hard drawn copper	104	173	550	25–45	1.
Iron B. B.	104	153	450	45	18.

Soft copper is assumed to have a conductivity of 99%, while hard drawn shows a loss of 2% in conductivity.

A comparison of the years of life that must be obtained from iron wire to give equal cost with copper wire for various prices of copper is given in the following table, No. 4:

Years Life of Iron Wire for Equal Cost.

	With Toll Lines of No. 14 N. B. S. Copper. Price of Copper.				With Toll Lines of No. 12 N. B. S. Copper. Price of Copper.			
	12c	16c	20c	24c	12c	16c	20c	24c
B. B. Iron No. 6 B. W. G.	..	..	27	19	26	14	12	9
B. B. Iron No. 8 B. W. G.	30	20	15	12	14	9	8	7
B. B. Iron No. 10 B. W. G.	19	13	10	9	10	7	6	5
B. B. Iron No. 12 B. W. G.	14	10	8	7	8	5	5	4
Exchange Lines.								
B. B. Iron No. 12 B. W. G.	10	8	7	6	7	5	4	3
B. B. Iron No. 14 B. W. G.	9	7	6	5	6	5	4	3

From the experience of a number of the telephone companies, it appears that the life of iron wire under some conditions is as short as one year, while under the most favorable conditions it may be 25 years or longer. Classifying roughly the experience as reported, the life of iron wire is as follows:

Near blast furnaces or smelters or on the sea coast, 1 year.

In large cities where soft coal is used or near the sea coast, 3 to 5 years.

In towns where there is little soft coal smoke, 5 to 15 years.

In country districts where there is little or no smoke, 15 to 25 years.

Transmission Equivalents of Open Wire Circuits.

The study of transmission is a subject in itself and requires considerable technical knowledge. Hence it will be necessary for us to confine ourselves to some practical data in common use. In general the transmission of telephone currents on telephone lines is principally affected by the resistance of the conductors; and by the relative values of the capacity and induction of the line wires.

The transmission losses of different kinds of cables, wires and equipment have been carefully determined and these losses when expressed in terms of the length of No. 19 gauge cable (of 0.054 m.f. capacity and 88 ohms loop resistance per mile) having an equivalent transmission loss. The limiting resistance of subscribers' loops in No. 22 gauge cable, which is the gauge most generally used, is taken as the basis from which the allowable length of other cables or wires may be calculated by means of the "transmission equivalents."

The allowable subscriber loop resistance from the central office protector to the substation protector usually depends upon the number of offices in the exchange district. The following values have been given (Table No. 5):

Offices in Exchange District	Limiting Resistance in No. 22 Gauge Cable
1 to 2	500 ohms
3	450 ohms
4 to 6	400 ohms

The "transmission equivalents" for different kinds of wire in exchange use are as follows:

One Mile of Metallic Circuit in Cable or Open Wire.	"Transmission Equivalents."
No. 22 B. & S. G. Cable (600 pair)	1.66 Miles of Standard Cable
No. 22 B. & S. G. Cable (400 pair or less)	1.53 " " " "
No. 19 B. & S. G. Cable	1.11 " " " "
No. 14 N. B. S. G. Copper Wire	.132 " " " "
No. 12 N. B. S. G. Copper Wire	.079 " " " "
No. 14 B. W. G. Iron Wire	.40 " " " "
No. 12 B. W. G. Iron Wire	.32 " " " "
No. 14 B. & S. G. Rubber Insulated Outside Distributing Wire	.8 " " " "
No. 18 B. & S. G. Twisted Pair Bridle Wire	1.1 " " " "
No. 17 B. & S. G. Twisted Pair Copper Steel Wire	1.7 " " " "

The following tables, Nos. 6 and 7, show the equivalent transmission in miles of No. 8 BWG* copper wire as compared with other sizes shown and also shows the limiting length of iron circuit in miles:

Wire.	Diam., Inches.	Weight per Mile, Pounds.	Equivalent Transmission in Miles of No. 8 B. W. G. Copper Wire.
Copper No. 8 B. W. G.	.165	435	1.0
Copper No. 12 N. B. S. G.	.104	173	2.2
Copper No. 14 N. B. S. G.	.080	102	3.6
B. B. Iron No. 6 B. W. G.	.203	580	5.0
B. B. Iron No. 8 B. W. G.	.165	383	6.0
B. B. Iron No. 10 B. W. G.	.134	253	7.0
B. B. Iron No. 12 B. W. G.	.109	167	9.0

Limiting Length of Iron Circuit–Miles.

Wire.	Toll Lines not Used in Making Up Longer Circuits.	Loops to Center Checking Points.
B. B. Iron No. 6 B. W. G.	110	30
B. B. Iron No. 8 B. W. G.	85	25
B. B. Iron No. 10 B. W. G.	75	20
B. B. Iron No. 12 B. W. G.	60	15

*B. W. G. equals Birmingham Wire Gauge.

Bell Compiles Figures on American Republics

New York City Telephone and Telegraph Statistics of American Republics are given in a recent pamphlet published by the American Telephone and Telegraph Co. Included also are the figures for British, French and Dutch Guiana and British Honduras so that complete statistics of Central and South America are presented. Among the tables are those showing distribution of telephones by countries, telephone development and wire mileage, telephone development in the largest city of each country, estimated telephone investment, telephone and telegraph gross earnings for 1922 and telegraph wire, offices and messages. Several graphical charts are also included. The figures show that Argentina with 143,093 telephones has the largest number of telephones of the countries listed. Brazil, Cuba, Mexico and Chile follow in order. Paraguay, British Honduras and French Guiana have the smallest number of telephones. In telephone development per 100 population, Argentina, Uruguay, Cuba and Panama lead in the order named while Haiti and Paraguay have the smallest development. In all of the countries the development is small compared with the United States. The United States has 13.06 telephones per 100 population while Argentina, the next in order, has only 1.59 telephones per 100 population. The same condition exists in the telephone development of the largest cities of each country, New York City having 18.2 telephones per 100 population while Havana, the next in order, has 6.5 telephones per 100 population. Asuncion, Paraguay, with 87,000 population and only 90 telephones brings up the rear with the lowest development of the largest city of any country listed.

Transmitter Circuit Theory

An Analytical Study of the Transmitter Circuit With an Extension of the Alternating Current Theory and Its Application in Local Battery and Common Battery Circuits

By A. F. PUCHSTEIN and WARD H. SNOOK

It is believed that there exists today no published method whereby the characteristics of telephone transmitter circuits may be calculated, in spite of the fact that such apparatus has been used for many years. There are available methods which cover the very simplest case—that of circuits which contain resistance only—or else only resistance and inductance. The case where resistance, inductance and capacity are present in any combination has apparently not yet been treated in any publication.

It is hoped to present and justify in this article a means for handling the more general problem. This will be sufficiently broad to include both common battery and local battery circuits, either with or without transformers. The art has not reached the stage where exact quantitative results can be expected, but the material will be found useful in analyzing the performance of various kinds of circuits and will be helpful in finding the way for improvements.

Elementary Consideration of Transmitter Circuit

Figure 1 shows the typical circuit without inductance or capacity. It is

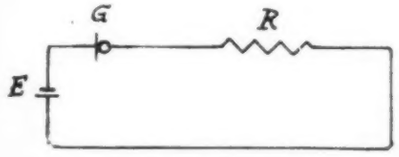


Fig. 1—Transmitter Feeding Circuit With Resistance Only.

customary to assume that the resistance of the transmitter varies harmonically at a fixed frequency of f cycles per second. The maximum range of this variation up or down is taken as r ohms. It is assumed also that the transmitter resistance has a constant part of G ohms. The resistance in the remainder of the circuit is R ohms. The total resistance in the circuit at an instant t is then given by the expression,

$$R = G + R + r \sin \omega t \quad \ldots\ldots\ldots (1)$$

and the current i by,

$$i = \frac{E}{G + R + r \sin \omega t} \quad \ldots\ldots\ldots (2)$$

where E is the battery voltage.

Since r is small relative to G + R, it may for the present be neglected. The ratio $\frac{E}{G+R}$ will then represent the constant value of the direct current component. This quantity is taken as constant, though as a matter of fact it fluctuates more or less owing to the non-constant character of the carbon contact resistance. The crest value of the alternating component may then be taken as one-half the difference between the maximum and minimum values of i, on the assumption that G remains constant. This gives,

$$I_{a.c.max.} = \frac{1}{2}\left[\frac{E}{G+R-r} - \frac{E}{G+R+r}\right] = \frac{Er}{(G+R)^2 - r^2} \quad \ldots\ldots\ldots (3)$$

The r^2 in the denominator may be neglected.

It is instructive to look at the problem also from another point of view. If the equation (2) be written in the form,

$$i = \frac{E}{(G+R)\left(1 + \frac{r}{G+R}\sin \omega t\right)} \quad \ldots (4)$$

then, with the aid of the series,

$$\frac{1}{1+x} = 1 - x + x^2 - x^3 + x^4 - \ldots$$

the right hand member may be expanded into,

$$i = \frac{E}{G+R}\left[1 - \frac{r}{G+R}\sin \omega t + \left(\frac{r}{G+R}\sin \omega t\right)^2 - \left(\frac{r}{G+R}\sin \omega t\right)^3 + \ldots\right] \quad \ldots\ldots (5)$$

In this expression, again, all terms with an exponent greater than 1 can be neglected. These terms represent the distortion due to the transmitter action.

The expression for current thus becomes,

$$i = \frac{E}{G+R}\left[1 - \frac{r}{G+R}\sin \omega t\right] \quad \ldots . (6)$$

Numerically, this result is practically the same as the previous one given in equation (2). It shows that the current i through the transmitter consists of a direct current, equal to $\frac{E}{G+R}$, and an alternating component of which the maximum value is,

$$I_{a.c.max.} = \frac{Er}{(G+R)^2} = \frac{Er/(G+R)}{G+R} . (7)$$

Extension of Alternating Current Solution

From equation (7), the transmitter and battery act as an alternator of which the maximum cyclic e.m.f. is,

$$e = Er/(G+R) \quad \ldots\ldots\ldots\ldots (8)$$

This e.m.f. acts on a circuit of which the impedance is G + R. If, now, the transmitter feeds alternating current into the more general circuit, its alternating e.m.f. will not be affected by the nature of the circuit, so long as the direct current through it has the same value. It is permissible, therefore, to replace the impedance G + R by the impedance Z. It is necessary to interpret Z as the total impedance in the path of the alternating current. Equation (7) then becomes,

$$I_{a.c.max.} = \frac{Er/(G+R)}{Z} \quad \ldots\ldots\ldots (9)$$

It is convenient for some purposes to express r as a percentage of G, or, r = pG. For example, the maximum value of the alternating current in a circuit containing only resistance and capacity may be written as,

$$I_{a.c.max.} = \frac{EpG}{(G+R)\sqrt{(G+R)^2 + X^2}} . (10)$$

A transmitter with a large r will give a better transmission than will a transmitter with a small r. Also, by taking the derivative of this equation with respect to G and equating to zero, it is possible to find the best value of transmitter resistance, on the assumption that p is constant. The solution is not very convenient and will not be given. If needed, it may be found by plotting the relation between $I_{a.c.}$ and G in the form of a curve. The best value of G is then given by the low point in the graph. X is the reactance in ohms =

$2\pi fL = \omega L$, when L is the inductance in henrys.

If the arrangement is such that an inductive shunt is provided for the flow of the battery current, with a series capacity in the path of the alternating current, the X in equation (10) may be replaced by $\omega L - \frac{1}{\omega C}$, where C is the capacity in farads.

While it is not a true representation, the case met with in practice may be illustrated as shown in Figure 2. Here the actual line is replaced by an equivalent shunt circuit. Z in formula (9) is interpreted as the sum of the local

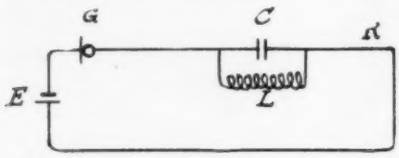


Fig. 2—Transmittetr Feeding a Containing Resistance, Inductance and Capacity.

and line sending end impedances, and R as the sum of the local and line sending end resistances in the path of the direct current, not including the transmitter resistance G.

In the above study there is some question as to the legitimacy of the substitution of Z for G + R. Further light is thrown on this question by noticing that if the condenser, in Figure 2, be omitted the circuit equation is

$$E = L\frac{di}{dt} + (G + R + r\sin\omega t)i. \quad (11)$$

and if the inductance be omitted,

$$E = (G+R+r\sin\omega t)i + (1/C)\int idt \quad (12)$$

The latter arrangement is inoperative, except when a transformer or inductive shunt are used. It is necessary then to select the former for further study. Since the alternating current is small relatively to the direct current component, the i in equation (11) may be regarded as constant and equal to $I_{a.c.} = \frac{E}{G+R}$, and it can be written,

$$E = (G+R+r\sin\omega t)I_{a.c.} + L\frac{di}{dt}. \quad (13)$$

The solution of equation (13) gives the same result as previously obtained, except that a transient term, $-(\frac{G+R}{L})t$, is added. The transient term in this and in the following case merely indicates that the current fed into the circuit does not adjust itself immediately to changes in circuit conditions, but that there is a certain lag, which tends to produce distortion.

The exact result of solving equation (11), expressed in symbols, would be,

$$i = -\frac{E\int \epsilon^{\frac{(G+R)}{L}t}\cdot\epsilon^{-\frac{r}{\omega L}\cos\omega t}dt}{\epsilon^{\frac{(G+R)}{L}t}\cdot\epsilon^{-\frac{r}{\omega L}\cos\omega t}} + K\epsilon^{-\frac{(G+R)}{L}t + \frac{r}{\omega L}\cos\omega t} \quad (14)$$

As the evaluation of the integral is difficult, we may use the expansion $\epsilon^{-x} = 1 - x + x^2 - x^3 + \cdots$, in place of $\epsilon^{-\frac{r}{\omega L}\cos\omega t}$, and since the exponent is small, it is permissible to neglect all terms above the second. The result of the integration then is,

$$i = \frac{I_{a.c.} - (Er/\omega L)\dfrac{\sin\left(\omega t + \tan^{-1}\left(\frac{G+R}{\omega L}\right)\right)}{Z}}{1 - (r/\omega L)\cos\omega t} \quad \ldots\ldots(15)$$

Here again, the second term in the numerator is small and may in many cases be neglected, with the result that

$$i = \frac{I_{a.c.}}{1 - (r/\omega L)\cos\omega t} \quad \ldots\ldots(16)$$

By algebraic division, as in equations (4) and (5), this result may be reduced to

$$I_{a.c.,max.} = \frac{rI_{a.c.}}{\omega L} = \frac{Er}{(G+R)\omega L} \quad \ldots(17)$$

This result differs from the former, equation (9), only in that the reactance ωL apears in place of the impedance Z. It is the same provided ωL is not too small. We therefore conclude that the simple treatment above adopted is generally applicable.

Application to Local Battery Circuit

However, the circuits represented in Figures 1 and 2 are no longer used. They have been replaced in the local battery set by the arrangement shown in Figure 3. Here it is sufficient for

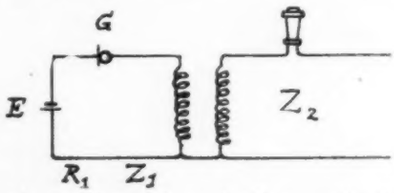
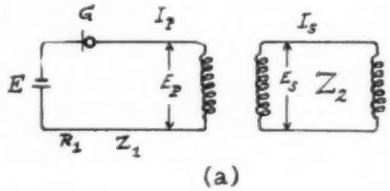


Fig. 3—Transmitter Feeding a Circuit Through An Induction Coil.

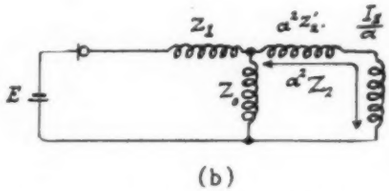
many purposes to assume that the transformer has a core with zero reluctance and zero core loss. It is then necessary only to take as Z_2 the sum of the local secondary and the line sending and impedances. This sum is divided by the square of the ratio of coil turns and the result added to the total impedance in the battery circuit. This total sum is the value of Z to be used in formula (9). The R is replaced by R_1, the resistance in the battery circuit. The voltage and current on the secondary side are then found in the usual way by multiplying or dividing by the ratio of turns.

In those cases where the reluctance and core loss can not be neglected, the actual transformer may be replaced by the equivalent circuit shown in Figure 4. The method of making the transfer is evident by comparing the symbols in (a) and (b).

The analysis is made exactly as before, except that Z is replaced by $Z_1 + \frac{Z_0 Z_2}{Z_0 + Z_2}$. Z_0 is the excitation impedance of the primary. Z_1 is the local impedance of the primary. Z_2 is the total impedance in the secondary circuit multiplied by the square of the ratio of turns. Formula (9) then gives the value of the alternating current



(a)



(b)

Fig. 4—Actual Transformer and Its Equivalent Net Work.

on the battery side, and formula (8) the value of the alternating voltage. The current and voltage delivered to the secondary side may be found by applying the laws of series and parallel circuits to Figure 4. It is convenient also to use the following expressions which have been adapted from the work of Dr. C. P. Steinmetz,

$$\frac{E_p}{E_s} = a\frac{1 + z_1/z_0 + z_1/a^2z_2}{1 - z'_2/z_2} \quad \ldots\ldots(18)$$

$$\frac{I_p}{I_s} = \frac{1}{a}\left[1 + a^2\frac{z_2}{z_1}\right] \quad \ldots(19)$$

where the symbols have the same meaning as before, with the addition that a is the ratio of turns and z'_2 is the local impedance of the secondary winding. R_1+G is taken the same as previously for the resistance in the path of the battery current.

Application to Common Battery Circuits

The same idea may be applied to the calculation of common battery circuits. In Figure 5, the resistance in the path of the direct current, as viewed from the battery, is the sum of the coil and battery resistances, plus the sending end resistance of the line and substation apparatus. Either transmitter can then be regarded as an alternating current generator of which the maximum cyclic voltage is equal to the product of the direct current in the transmitter, times the quantity r. The direct current delivered to the transmitter is found by summing up in the proper way all resistances in its path and dividing into the battery voltage. Similarly, the alternating current delivered to the receiver is found by summing up in the proper way the effect of all impedances in its path and dividing into the "generator" voltage. The actual work requires the use of hyperbolic functions and is beyond the scope of this article.

It is, of course, understood that all impedances are vector quantities and that the line "constants" are distributed. A frequency of 800 cycles may be assumed in the calculations, though it is better to use a number of different values. It is not yet possible to take the effects due to the distributed capacity of the transformer windings into account. Also, the hysteresis of the iron core causes the different frequencies of the voice currents to react upon each other to a certain extent. This factor is not as yet accessible to analysis.

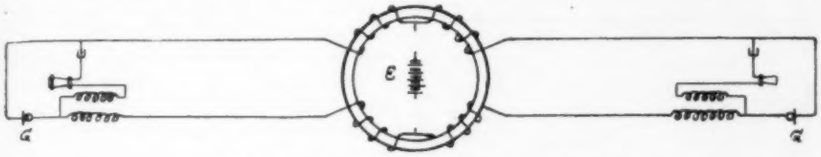


Fig. 5—The Common Battery Circuit.

OUR LITERARY DIGEST

Review of Recent Publications on the Telephone and Allied Subjects

Elements of Electrical Engineering, by George D. Shepardson, of The Macmillan Company, New York.

This book is designed for use as an introductory text book in technical schools and colleges. As such, it includes a discussion of the fundamental concepts of electricity and magnetism and their application to the more important types of electrical machinery. No doubt it will serve excellently for the purpose for which it was designed, but the present reviewer is interested in it from another angle. For the first time in a number of years experience with electrical engineering text books, has he found an author who seems to recognize the fact that there are important applications of electrical principles in the telephone. Of course, those who are familiar with Professor Shepardson's book "Telephone Apparatus" would expect to find that recognition in a book of his on general electrical engineering. A majority of authors of electrical engineering text books draw their illustrative material and problems for student solution, almost exclusively from the field of power generation and distribution. Professor Shepardson does not draw his material from any one field but calls upon the electric power, electric railway, illumination, telegraph, telephone and even the radio field to furnish examples. Furthermore, there seems to be an excellent balance of the various classes of material and the result is that the book gives a broader view of the electrical engineering field than any elementary text book we have seen. We do not presume to advise the college teacher concerning the books that he should use in his courses but we can recommend this book heartily to the telephone worker who has had the advantage of a good high school course in physics and who has the ambition to extend his knowledge of electrical principles and their application in telephony. Such a one will find it to be a valuable text for study and reference.

Where to Seek for Scientific Facts, by Alec. B. Eason, S. Rentell and Co., Ltd., London.

This little book published in London has for its object the placing before the reader the sources of information on various technical subjects. It gives lists of books and periodicals classified by subjects and indicates the principal published indices of scientific literature. The lists apply primarily to engineering and electrical subjects. While the libraries mentioned are not available in this country, the lists of publications which include all of the principal ones in a large number of countries, will be of much service to anyone who is making an extensive library study on an engineering subject.

International Issues Treatise on Southern Pine Poles.

Something more than an ordinary catalog or advertising circular is the beautifully printed publication of the International Creosoting and Construction Co. of Galveston, Tex., describing International pressure creosoted southern yellow pine poles. On the title page it is described as "A Compendium on Creosoted Poles and International Methods of Pole Production, Treatment and Distribution." Nearly fifty years ago the organization now known as the International Creosoting and Construction Co. began its pioneer work in the development of timber preservation and the publication is an effort to show how the experience of the past has been linked with the scientific skill of the present.

The story of southern pine as a pole timber is told by picture and by word from the time of the felling of the tree to time of service in the line. Produced in the forests of western Louisiana, eastern Texas, and southern Arkansas, the poles are concentrated at yards of the treating plants at Texarkana and Beaumont, Tex. Here they are stacked in orderly piles with proper separation between poles so that the seasoning process may take place without the possibility of decay starting. From the seasoning piles, the poles are loaded onto the cylinder trams and are taken to the treating cylinders. Here they go through the treating process. After treatment they are loaded for shipment to all parts of the country.

Complete descriptions of the two processes of treatment, the Bethell or full-cell and the Rueping or empty cell process, are given, together with the specifications for the treatments and for the creosote oil used. Samples of the charge records and pictures illustrate the precautions that are taken to insure that the timber receives proper treatment and that a uniform product is the result. In addition to the description of the production and treatment of southern pine poles, there are many tables of data that are of value to the construction engineer, including strength of pole timbers, sizes of poles carried in stock, annual charge for different length of life and cost of poles, and standard lengths, sizes and volumes of poles. The information has been compiled from standard sources and the text was reviewed before publication by men in the field of timber production and treatment and engineers of wide experience in pole use. In fact the publication is more in the nature of a brief treatise on southern pine pole production and treatment than of an advertising circular. It is worthy of a permanent place in the files of all pole users.

Al Johnson's Business Calls for Bigger Quarters

Chicago, Ill.—A. J. Johnson Co., manufacturers' representative, specializing in supplies for telephone companies, has been compelled by growth of business to move into larger quarters at 217 North Desplaines street, Chicago.

Industrial Standardization

Extracts From the Year Book of the American Engineering Standards Committee Give Details of Organization and Procedure for Establishing Industrial Standards

Industrial standardization consists in singling out specific products and materials, in settling upon their properties and dimensions, and in concentrating upon them both in production and in use—all to the end of bringing about the greatest possible industrial efficiency. This includes:

1. Nomenclature. Definitions of technical terms used in specifications and contracts and in other technical work. Abbreviations. Symbols for quantities used in equations and formulas. Graphical symbols (ideographs).
2. Uniformity in dimensions necessary to secure interchangeability of parts and supplies, and the interworking of apparatus.
3. Specifications for materials and equipment.
4. Methods of test.
5. Rating of machinery, tools and apparataus.
6. Provisions for safety.
7. Rules for the operation of apparatus and machinery in industrial establishments.
8. Concentration upon the optimum number of types, sizes and grades of manufactures products.

The important role which standaardization plays in industrial evolution, and its economic and social potentialities are only beginning to be generally understood. Among the many important advantages of standardization are that: it simplifies manufacturing processes; it stabilizes production and employment, since it makes it safe for the manufacturer to accumulate stock during periods of slack orders which he can not safely do with an unstandardized product; it lowers cost to the public by making mass production possible; it enables buyer and seller to speak the same language and makes it possible for competitive sellers to do likewise; it reduces selling cost; it stimulates research and makes for the elimination of antiquated methods and products; and by concentration on essentials, and the consequent suppression of confusing elements intended merely for sales effect, it helps to base competition squarely upon efficiency in production and distribution and upon intrinsic merit of product.

The process of industrial standardization may be conveniently divided into four stages, namely: (1) by individual firms; (2) by societies and associations; (3) on a national scale; (4) on an international scale. Standardization by individual firms is now well developed and has been an essential factor in the development of mass production. This inevitably gave rise to standardization for entire branches of industry which has been carried out by technical societies, trade associations and government departments working individually. In turn this has led to inter-industry standardization on a national scale. Standardization cannot reach its greatest effectiveness until it is treated as a national inter-industry problem and all leading industrial countries have found it necessary to establish national industrial standardizing bodies. There are at present sixteen such national bodies.

EDITOR'S NOTE: Interest in standardization has grown rapidly in the telephone field in recent years and has been given a new impetus by the formation of a telephone group as a member-body of the American Engineering Standards Committee and the appointment of a representative of the United States Independent Telephone Association as a member of the main committee. It will be an important topic of discussion at telephone conventions and meetings during the coming convention year.

In the belief that the telephone field and particularly the Independent side of the field has never received an adequate presentation of the subject of standardization and the organization which has been perfected to bring it about, we have had this article prepared. The greater part of the article is made up of extracts from the year book of the American Engineering Standards Committee which are given almost verbatim as they appear in that publication.

We do not know a better way in which this matter could be presented and we are sure that a reading of the article will give a much clearer understanding of what standardization really is and of the orderly and democratic procedure followed in the creation of the standards.

In order to make possible standardization on a national scale, there must be a central clearing house to bring about systematic co-operation among the hundreds of organizations on the innumerable problems that are crowding for solution. To fulfill the need for such a clearing house, the American Engineering Standards Committee was organized in 1918, the initiative having been taken by five national engineering societies.

The Main Committee.

The American Engineering Standards Committee itself, usually referred to as the main committee, is primarily an administrative and policy forming body. Under the constitution of the organization, the whole executive authority is vested in the main committee, whose personnel consists of representatives of a group of national organizations which, by subscribing to the constitution, ultimately become responsible for the whole movement. These organizations are termed member-bodies. At present these include seven departments of the federal government, nine national engineering societies and eighteen national associations.

There are a smaller executive committee and administrative subcommittees to act for the main committee in the intervals between meetings and to provide for the more detailed and routine administrative work, which is carried out under a set of by-laws. Permanent offices and staff are maintained in the Engineering Societies' Building, New York.

Methods of Work.

The method of work is simply a systematic plan of co-operation by which all organizations interested in any particular standardization project participate (1) in deciding whether the work shall be undertaken at all. (2) in formulating the standard, and (3) in its ultimate approval as an "American Standard" or a "Tentative American Standard."

The formulation of each standard, including the detailed work and tech-

nical decisions is in the hands of a working committee called a "sectional committee." The sectional committee is made up of representatives designated by the various bodies interested in the particular project at hand. This is clearly shown in the chart Fig. 1. Each sectional committee is organized by, and under the leadership of one or more of the principal bodies interested. Such bodies are known as "sponsors."

After the standard has been formulated and agreement upon it has been reached in the sectional committee, it is submitted, through the sponsor, to the main committee for approval. In acting on the approval of standards as "American Standards" or "Tentative American Standards," the main committee considers the adequacy of representation on the sectional committee of the various interests, and the procedure that has been followed but it does not concern itself with the technical details of the standards. Hence, approval of the A. E. S. C. means, not that the main committee has itself worked over and passed upon the technical details of the standard, but that it has satisfied itself that all organizations concerned had an opportunity to participate in the work, that the work has been carried out under a procedure that has been regular, open and above board, and that the standard represents a real national consensus on what is best in American engineering and industrial practice, and hence that it either already does or may reasonably be expected to play a significant, if not a controlling role in the processes and materials in the industry concerned.

Initiation of Projects.

The A. E. S. C. is not an initiating body, and the work on a project is undertaken only upon formal request from a responsible body, and then only after the committee has assured itself that it is the desire of the industry that the work should go forward.

Experience has shown that by far the most satisfactory method of determining whether industry desires the work is by a formal conference of the bodies concerned with the proposed project. The conference is asked to decide: (1) whether the work shall be undertaken; (2) if so, what its scope shall be; (3) how the work shall be organized; (4) how it shall be related to any other work having an important bearing on it.

There are decided advantages in the conference method. It focuses the attention of the organizations and interest concerned in the subject, and it affords a definite occasion to the technical and trade press for giving wide publicity to the topics under discussion. Experience has shown that when men are able, through a conference of this kind, to get a comprehensive view of the whole field, and to understand each other's point of view, differences tend to disappear, and agreements are much more easily reached than would otherwise be possible through any machinery less representative in its functioning.

Sectional Committees.

The sectional committee is the forum in which agreements are worked out between the various organizations which speak for those branches of the industry concerned in the particular standard for the formulation of which the sectional committee is responsible. Hence the sectional committee is necessarily made up primarily of accredited representatives of such organizations. A sectional committee also usually contains one or more outstanding specialists, not representing any particular organization.

The relation and responsibilities of a member of a sectional committee to the co-operating body which he officially represents are important. It is his duty to keep sufficiently in touch with his organization so that he can correctly interpret its attitude in the development of the work and in participating in decisions of the sectional committee; to keep his organization informed of developments; to act as a leader in the formulation of the policies of the organization in regard to the matters with which he is dealing, and to refer back questions upon which he feels unauthorized to speak for his organization. Some co-operating bodies require their representatives to render written reports which may be printed and circulated to the members of the organization.

The final report of the sectional committee on a standard is by signed ballot, and the result is transmitted in detail by the sponsor to the main committee when the standard is submitted to it for approval.

Sponsors.

In one important particular the method of work of the committee differs from that of the foreign national standardizing bodies. When the committee was formed there were already a large number of organizations doing standardization work, some of which had been accomplished, and were engaged in very important work. This led to the policy of decentralization through the use of "sponsor" organizations. A sponsor is a co-operating body, designated by the main committee, responsible for the development of any standard or group of standards, by a sectional committee. The use of this plan makes the committee the most decentralized of all national standardizing bodies.

Sponsors need not be represented on the main committee. Two or more sponsor bodies may be designated as joint sponsors for a standard or a group of standards.

The sponsor organizes the sectional committee and is responsible for seeing that the work is continuously and effectively prosecuted and that the necessary administrative and clerical services are provided. The sponsor provides also for the publication of the standard.

Information Service.

The committee is in a position to supply full and accurate information on standards which have been published in foreign countries and also on work in progress. It is planned that a complete file of all American and foreign standards of significance shall be maintained. About 3500 standards have been card indexed. A special service to sustaining members in the form of information bulletins on the standardization work in this country and abroad, has been initiated. The committee also regularly supplies to the technical and trade press and to technical and trade associations, information in regard to the progress of work which is being carried out under its auspices.

Membership.

In a very real sense the American Engineering Standards Committee is a movement rather than merely a formal federation—a co-operative movement in which the great number of industrial, technical and governmental bodies engaged in standardization activities are broadening and unifying their standardization work into a consistent system of national industrial standards. The nucleus of the movement is the main committee. The different types of membership depend upon the part which the co-operating organization is taking in the movement.

Member.

A member is one of the individuals constituting the main committee. They are the representative of member bodies, each body appointing one, two or three representatives.

Member-Body.

A member body is an organization or a group of organizations having representation on the main committee. The annual dues of each member body are five hundred dollars for each representative. During 1922 the telephone group was added with three representatives. The constituents of the group are the Bell Telephone

System and the United States Independent Telephone Association. There are now 23 member-bodies representing seven departments of the federal government, nine national engineering societies and 18 national industrial associations.

Sustaining Member.

A sustaining member is an organization, firm or individual interested in the work of the committee and contributing directly to its support. This plan has been adopted as a means of permanent financing of the work. Subscriptions range from $25 to $4000 per annum, based on gross receipts of the business of the sustaining member.

Cooperating-Body.

A cooperating body is any organization officially cooperating in the work of the committee.

Relation to Industrial Associations.

Standardization being essentially a cooperative undertaking, must necessarily be predicated upon some form of organization. It is natural, if not inevitable, that both trade and technical associations, no matter for what purpose they may have originally been organized, should eventually concern themselves with standardization activities. As trade associations become more highly developed, it is inevitable that they enter more and more into technical work. When such technical work develops in volume, associations find it advantageous to employ staff engineers, as it has been done, for example, by the American Electric Railway Association, the National Electric Light Association, the American Petroleum Institute and the Associated General Contractors of America.

One of the principal, if not the principal activity of the technical staff is in connection with standardization problems. While the responsibility for decisions must always rest with committees made up chiefly of men rendering volunteer service, there is a vast amount of detailed work that can be cleared up much more economically and satisfactorily by staff men working under the direction of such committees. There is a decided tendency for associations to make greater and greater use of staff men in connection with standardization activities. Such use of its technical staff enables an association, through its various committees and representatives, to keep thoroughly in touch with the standardization developments in its own and related fields.

Standardization Projects.

In the latter part of the year book of the A. E. S. C. for 1924 is a detailed list of the projects which, on March 31, 1924, had an official status before the committee. Each project is given a designation number which is used for identifying the project and the stage of development as indicated. The following list of projects is taken from the list given in the year book as indicating those in which the telephone industry is particularly interested:

C-1. Electric Wiring and Apparatus in Relation to Fire Hazard, Regulations for ("National Electrical Code").

C-2. Electrical Safety Code ("National Electrical Safety Code") Crossing Specifications.

C-5. Lightning, Code on Protection Against

C-8. Wires and Cables (Other than Telephone and Telegraph), Insulated

C-10. Symbols for Electrical Equipment of Buildings

C-13. Poles, Tubular Steel, Specifications for

C-14.

C-16. Radio.

C-17. Overhead Line Materials

G-8. Zinc Coating of Iron and Steel, Specifications for

These are in various stages of progress ranging from C-1 and C-2 which are revisions of existing codes and C-10 which is published to C-17 which has been proposed officially but sponsors for which have not been appointed.

There are other projects in which the telephone industry is interested in a general way as, for example, those covering tests of Portland cement and concrete and the various safety rules covering ladders, building exits, floor and wall openings, ventilation and industrial sanitation.

Various organizations in the telephone field or closely allied to it have served as cooperating-bodies on a number of the projects. The telephone group is a member-body and is serving as a cooperating-body in projects C-1 and C-14, being the sponsor-body for the latter project. Prior to the organization of the telephone group the American Telephone and Telegraph Co. and Associated Bell Telephone Companies and the United States Independent Telephone Association have served as cooperating bodies on a number of projects including most of those in the foregoing list. Telegraph companies and the telephone and telegraph section of the American Railway Association are cooperating-bodies in projects C-2, C-5, C-13, C-14, and G-8. Pole producers associations have been cooperating-bodies in projects C-2, C-13 and C-14.

Secretary Hoover Calls Third National Radio Conference

Washington, D. C.—Announcement has been made by Secretary Hoover of the calling of the Third National conference for the better voluntary regulation of radio. The conference will be held at Washington, beginning September 30th.

Two such conferences have already been held, one in February, 1922, and one in March, 1923, both of which were generally attended by the persons and organizations interested. The result has been a lessening friction and misunderstanding through the voluntary co-operation of the industry, the public and the Department of Commerce, especially in the reduction of interference and the improvement of service.

The growth of radio and particularly the multiplication of broadcasting stations and the consequent congestion of the air has made necessary a consideration of many subjects and perhaps a revision of some present methods. Some of the matters which will be discussed and considered at the conference are:

Revision of the present frequency or wave length allocations, to reduce interference.

Use of high frequencies or short waves.

Classification of broadcasting stations; possible discontinuance of Class C stations.

Interconnection of broadcasting stations.

Limitation of power; division of time; zoning of broadcasting stations.

Means for distinguishing the identity of amateur calls from foreign countries.

Interference by electrical devices other than radio transmitting stations.

Relations between government and commercial services.

Such other topics as may be proposed by the conference.

To facilitate the work of the conference the various groups in the radio field will be asked to name representatives who will constitute the formal advisory committee of the conference. As at present planned, the groups to be represented will be as follows: Listeners, Marine Service, Broadcasting (one from each inspection district); Engineering, Transoceanic Communication, Wire Inter-Connections, Manufacturers, Amateurs, Point-to-point Communication, Government Departments.

The committee so constituted will hold public hearings. All persons or organizations having any suggestions are urged to attend.

Cleveland to Have New Bell Skyscraping Home

Cleveland, O.—A monumental office building, rising 325 feet in tiers of terraced stories, estimated to cost $7,500,000, is projected for construction on the site now occupied by the Huron road hospital and the old Empire theater in Huron road, near Prospect avenue, by the Ohio Bell Telephone Company.

C. P. Cooper, president of the company, has conferred with City Manager Hopkins and Councilman William Potter, chairman of the Cleveland building code commission, to discuss the plans which necessitate an amendment of the building code.

Potter announced he would introduce a resolution before council next Monday night in an effort to grant the telephone company special dispensation to erect the structure. The building, according to present plans, exceeds the building code height limit by seventy-five feet.

Despite its unprecedented height, so far as Cleveland structures are concerned, the building, it is understood, would have only twenty stories. Nine of them, however, are to be eighteen feet high each to provide room for equipment.

Construction will be started within a short time after city council grants the company permission to erect the structure. The telephone company obtained the land, now occupied by the hospital and the theater more than a year ago, with the understanding the hospital was to vacate the property when title was transferred to the company July 1.

Purchase of the Huron road property by the telephone company was prompted by the need of new quarters for administrative offices and downtown exchanges after a study of the city's development that led to the designation of this property as the exact center of Cleveland.

The project, according to such information as is now available, would bring about the abandonment of the company's quarters in the Anisfield building at East Ninth street and Prospect avenue; offices in the 4300 Euclid avenue building and in the Electric building and the Main Exchange building.

The Main Exchange building will have to be abandoned regardless of the outcome of the company's present plans to make way for the union depot on the Square.

Above—Trim and husky Barber-Greene ditcher for telephone work. Right—The B-G machine "riding" a pipe-line.

B-G Ditcher Proves Versatility in Tough Pipeline Job

Aurora, Ill.—Telephone men interested in applying the economies of machine trench digging to telephone work get a vivid idea of the possibilities in this work from a record of the experience of J. C. Connor in laying 11 miles of pipe for the Prairie Pipe Line Company, near Joliet, Ill.

The trench was 9 inches wide and 33 inches deep and the 11 miles were dug in little more than a month's time with a Barber-Greene ditcher with only one man operating. The maximum run was 2,800 feet in 5 hours and 15 minutes.

Most of the digging was done astraddle of a 6-inch pipe, as is commonly done in the oil fields. All kinds of digging was encountered. In one point the operator was forced to run the line for 1,800 feet along the edge of a high bank. The machine dug this 1,800 feet with one crawler rubbing against the poles of a high bank on the other side. The supposed minimum clearance of the ditcher in width is 6 feet 6 inches. The actual minimum clearance in width for this distance of 1,800 feet was only 6 feet 3 inches.

In crossing a field in another part of the line many stumps were encountered. These stumps were simply pushed out while the machine went on digging. A boom was placed at the base of the stump and against the rear end of the machine and the stumps were pushed out while the machine moved along with its regular digging. Some of the stumps measured 30 inches across.

This machine has the vertical boom which enables the machine to dig straight down from the start. This type of digging boom eliminates the necessity of hand cleanup near obstructions.

In that connection the Barber-Greene company mentions that it would be possible to dig the post holes for the telephone transmission line which necessarily must accompany any pipe line of any length.

This machine also has the mechanical overload release sprocket which makes it "as Careful as Human Hands." Equipped with this sprocket, the machine goes along digging at a depth down to the maximum of 5 feet 6 inches. Whenever a real obstruction is encountered the sprocket slips the overload, the bucket line stops, and the rest of the machine runs idle until the inner part of the sprocket turns around to working position again. If the strain is still present the sprocket slips again. If the strain is not present the machine continues to work as before.

One of these Barber-Greene machines has just been bought by the Mountain States Telephone and Telegraph company of Denver, Colo.

LINE AND DESK

A MODERN CONSTRUCTION TRUCK BODY

A new type of construction truck with a specially designed body that is particularly suited to the needs of aerial and underground construction gangs has recently been added to the motor vehicle fleet of the Illinois Bell Tel. Co. The body was designed after a large amount of study had been given to the problem of truck transportation by engineers of the American Tel. and Tel. Co.

In the old type of truck, one of the disadvantages was that material and tools were piled together in the truck and in side boxes and much time was spent in looking for various tools and parts as they were needed. Moreover, the foreman could not tell at a glance whether he had a complete equipment of tools and materials and consequently, many extra trips had to be made for material that was overlooked.

With This Construction Truck Foreman Can Tell at a Glance if His Equipment Is Complete.

A large saving of time of the men can be made if the tools and materials have designated places on the truck. These trucks usually are in the warehouse every night and the stock of materials carried on the truck can be kept down to a minimum. Tools and materials not in immediate use on the job are not carried. In addition to having a place for everything that is to be carried, the truck has a permanent equipment for construction work. It is fitted with a power driven winch, pole derrick and centrifugal pump. A sheave which can be mounted across top rails permits the use of the winch for loading cable reels and other heavy material. Nor is the comfort and safety of the men forgotten. A folding seat is arranged to fold down over the winch when needed and a sanitary wooden keg is provided for drinking water.

SAFETY COMMITTEE MUST LEAD, NOT DRIVE.

For the safety committee to tell anyone what to think or what to do would be but to defeat the designated purpose for which it was instituted because people are reluctant toward being driven. From this fact we may deduce that the chief value of any safety organization lies in its ability to lead the employes, that is, to display its plans in such a manner that, unconsciously, the employe will reason out for himself the economic value of always being careful.—G. Leland Seaton in "Bell Telephone News."

INDUCTION DUE TO POWER CIRCUIT UNBALANCE

An Iowa subscriber asks the following questions concerning an inductive interference difficulty that has arisen in its exchange:

"We are seeking information in regard to high line noise on our rural grounded telephone lines.

"High line when first constructed was single-phase, 6,600 volts and the noise was hardly noticeable but now the company has made part of it three-phase and still 6,600 volts; so it is part single-phase and part three-phase.

"This third wire, of course, is on the feeding end. It has no transpositions in it. Should there be?

"Do high line companies have to keep their lines balanced or are they liable for same?"

The cause of the noise on the telephone lines is the unbalanced condition of the power circuit. On account of the fact that the line is three-phase over part of its length and single-phase over the remainder, the length of the three wires is not equal. If voltage readings were taken from each wire to ground, it would be found that the voltages were not equal. The shortest wire would have the highest voltage to ground. This voltage unbalance is the cause of noise in adjacent telephone lines. If the lines are close together, it is usually impossible to eliminate the noise even on perfectly insulated and balanced metallic telephone circuits. The noise on grounded circuits is frequently so strong that it is practically impossible to use the line.

The remedy for noise due to this cause must be applied to the power circuit. Two methods are available: either the line may be made three-phase over its entire length; or the single-phase branch may be separated from the three-phase line by the use of an insulating transformer. This is simply a one-to-one ratio power transformer of sufficient capacity to carry the load on the single-phase branch. The method to be used in a particular case depends upon the location and the lengths of the three-phase and single-phase circuits. Transpositions in the power circuit will not help as long as the circuit is unbalanced by the single-phase extension. Transpositions in the power line are desirable if the lines are close together or if they parallel for a considerable distance. It may be found, however, that the noise is so small after the power circuit is balanced by one of the methods described, that the expense of cutting transpositions into the power line will not be justified.

Regulations governing relations between power and telephone lines differ in different states but we believe in

most, if not all cases, where rules have been formulated, the power companies are required to maintain their circuits in a balanced condition. In all probability you could secure information as to the status of this matter by writing the secretary of your state telephone association. Power companies usually do not understand that an unbalanced condition of this kind is the cause of trouble on telephone lines. If the situation is explained to them, in many cases they are willing to make changes in their circuits to remove the trouble.

ROMANCE AND RESPONSIBILITY IN BUILDING TOLL CABLE LINE

There is romance in building a toll lead that is to carry a state's business messages.

There is romance, yes—but there is work, too; and there is responsibility for each individual member of the crew on the job.

To know and to realize thoroughly that the welfare of thousands, the prosperity of great cities, of the state, perhaps, depends on one's doing the job well—and then doing it well—that enters into the romantic interest in the work. Besides, a man has joy in the proper performance of a duty, the satisfaction in work well done.

We have certain specifications and routine and practical methods worked out on the job that help us in our work and assure us that the completed bit of plant will function in the giving of service. I am going to tell you something of the work routine of building an aerial cable line—a big toll cable, for we have just completed one of the biggest jobs of that sort ever constructed in our territory.

First, the pole lead is staked out by the engineers, the poles are shipped to the railroad siding nearest to the job and delivered on the job from the car, if possible. If that cannot be done, the poles are kept in different piles according to length if there is room.

Usually the poles then are hauled to proper locations for setting. One good man can spot the poles, with the help of the truck driver. Next comes the digging of the holes, which must be done to proper depth, according to sizes of the poles.

A crew of about ten groundmen will keep a crew of six men setting. Care should be taken to set particularly good poles on corners and in front of houses. Next comes the setting of the anchors. At a dead-end pole use two 10-foot anchor rods, through a cedar log at least 16 inches in diameter and eight feet long. On light corners, an approved patent anchor may be used if under six-foot pull; if the pull is greater, it is better to set a log anchor.

Guying the poles at dead-ends requires two 16-M guys, one a foot above the strand and the other eight inches below. On a corner of six feet or less, 6M or 10M may be used; on corners over this it is better to use 16M.

In stringing the strand and placing the rings, you should have a crew of about six linemen and four groundmen, four linemen and two groundmen to string the strand, one groundman at the reel and one at the truck to handle the running lines. They should pull about one mile of strand and lay it on the pole steps. You can pull one-half mile tight with 10-inch, three-sheave iron blocks and truck; place a strain guy over the snatch block on the pole at a point six inches below the strand when in place. Fifty or 75 feet from this pole, place a strain guy, run it back to the foot of the next pole and attach blocks; run another light strain guy, attached about four feet from the ground, back to the butt of the next pole. Pull the strand according to specifications. Let two linemen and one groundman place suspension bolts and ring through the strand. Care should be taken when stringing the strand not to injure the groundman.

In placing the cable, first the cable is shipped to the nearest railroad siding and unloaded from the car onto the truck with winch and hauled to the job and spotted at proper places to pull in without rehandling. Pulling in the cable, you should use a truck with a good winch. It requires about six linemen and two groundmen—one lineman to place the booster hooks and remove, and one lineman at the truck to place the snatch blocks and handle wire and line. One lineman should follow the end through and see that it gets through the rings, and tie it up same; place one line at the reel and tie up end. There should be one groundman to grease the cable and two linemen and one groundman to straighten rings and place marlin ties. This many men can place from five to seven reels in eight hours. Our new truck with winch is a big money-saver in this work.—Floyd Jay, in The Mouthpiece.

RADIOCASTER USES HOME-MADE MICROPHONE IN CANADA.

"Editor Telephone Engineer,
"Chicago, Ill.

"Sir: I notice on page 32 of your August issue a photo of a radio casting microphone consisting of an ordinary telephone microphone attached to a piece of broom handle.

"I may say that I used an identical device at Can. 4GH, located in this office (Saskatchewan Department of Telephones) until the end of last winter, when I substituted the ordinary microphone for a Northern Electric hanging switchboard type. The handle is made from a piece of bicycle handlebar sawed off to about a length of seven inches and flattened at one end, bored and bolted to the back of the microphone, and a rubber grip placed on the bar. This makes a very nice finished job and the results are excellent."

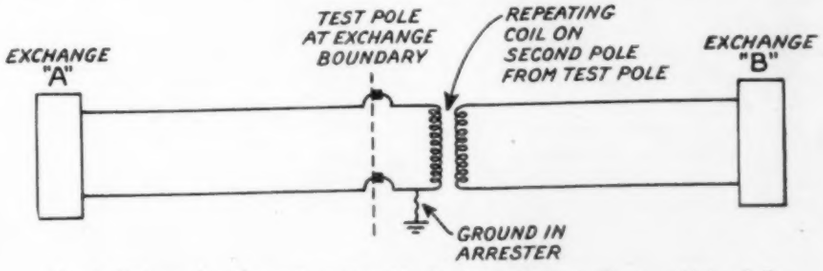
P. H. Jones.

Buchanan, Sask.

A CASE OF TROUBLE ON A JOINT TOLL LINE

In certain sections of the country, joint ownership of local toll lines is quite common. Two exchanges will build the toll line to the exchange boundaries where the wires are connected to form a through line. Each exchange owns and maintains the line to the point where the junction is made. Many arguments arise in the maintenance of these lines due to that peculiar kink in human nature that leads the maintenance man in each exchange always to be certain that any trouble is on the other fellow's portion of the line. T. E. Conrad, lineman of the Roachdale, (Ind.), Telephone Co. tells us of a peculiar case, in which the men at each exchange were perfectly sure the trouble was on the other half of the line because each one tested his own line and found it clear. The story is as follows:

"We have a joint line with another company which acted like it had a ground on it. I went to the test pole where our end joined the other company's end and tested back to our exchange and found our end clear. The



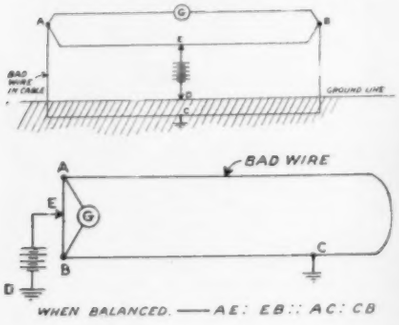
Here's Where the Mysterious Trouble Happened—Both Testers Claimed It Was on the Other Fellow's Line.

wire chief at the other exchange said he was sure his end was clear, so I drove back over the line but didn't find anything. The next day I went back and tested again. Our end was clear but when the line was connected through it was noisy. The wire chief claimed his end was clear because his meter showed no ground.

On the second pole from the test pole, on the other company's part of the line, they had installed a repeating coil. I finally went over on their end of the line and cut the line straight through and had them test. The line showed clear. Then I found the trouble in the lightning arrester on the side of the repeating coil toward our exchange. The trouble was on the other end of the line but the other fellow did not get it when he tested because it was beyond the repeating coil."

LOCATING GROUNDS IN BURIED CABLE.

The location of grounds in buried cable is quite a problem when a man does not have a bridge or is not familiar with one. I have used a method that has given good results, and have told several others about it. It requires two good wires between the terminals of the cable on each side of the trou-



Diagrams of Method Employed in Locating Grounds in Buried Cable.

ble. These may be of any size but one of them must be accessible at all points. A galvanometer is connected in series with one wire as shown in the drawing and a battery is tapped from the other wire to ground. When the place is found where the galvanometer gives no reading when the battery is connected between the wire and ground, the trouble is located. Of course, the wire used for the battery must be along the same route as the cable.

This test is really a Murray loop test with a slide wire bridge on a large scale. In the second sketch of the drawing the regular arrangement of the Murray loop is followed. The point, E, where the battery is connected to the battery wire in the test corresponds to the place where the pointer is connected to the slide wire in the regular Murray loop. This test does not require any calculations and does not require any special apparatus but a galvanometer or low reading voltmeter. It can be used wherever the additional good wires can be found. Often it is easier to string out wires for a block or even for several blocks than to dig up the cable in various places till the troube is found.—Contributed by Frank C. Morrill.

PROBLEM OF THE MISSING LANTERNS SOLVED.

Portsmouth, Ohio.

TELEPHONE ENGINEER,
Chicago:

No doubt many companies who do more or less ditch digging or other ground work have many lanterns stolen or broken.

The enclosed picture shows how we have eliminated most of this trouble.

A wooden mold is made about ½ in. all around larger than the base of the lanterns; it is from 3 to 5 in. deep, depending on the depth of the lantern base. The lantern is then set into the mold and the mold up to the oil hole is filled with a rich mix

Concrete Anchor Block for Lanterns Reduces Theft.

of concrete. After the concrete sets the base may be removed if so wanted. The lantern is then too heavy to be easily carried, thus eliminating the stealing. The extra weight also makes the lantern heavy enough to stand anywhere without danger of being blown over by the wind or being easily knocked over.

Previous to this year we have lost as high as 50 lanterns in a season. To date this year, we have not lost one by theft and have only three broken. —C. W. Kugelman.

Red Devil Tools Better Made

"Red Devil" Tools
Better Made

A slogan that we live up to in letter and spirit.

The cumulative knowledge and skill of over a quarter century's drop forging experience, combined with the best mechanical genius, are behind "Red Devil" Tools to guard our reputation.

"Red Devil" Electricians' Auger Bits

The worm is constructed to take hold quickly and strongly. No pushing—it pulls itself through. Bores with or against the grain of any wood. 10% greater clearance. No. 2403. Sizes 10, 11, 12 and 13/16ths.

"Red Devil" Havens' Grips

The breaking strain test is more than double that of other makes. Powerful —wire confined in gripping jaws never get loose until released. No. 368 for No. 8 and smaller wires. No. 369 for 1/2 inch and smaller wires.

Send for the electrical tool booklet

SMITH & HEMENWAY CO., Inc.
Mfrs. of "Red Devil" Tools
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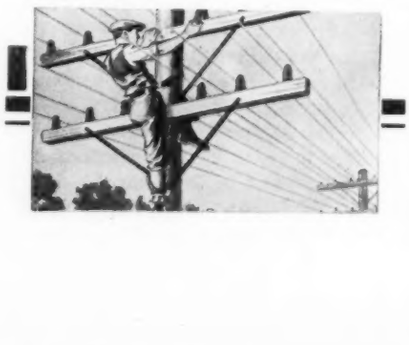
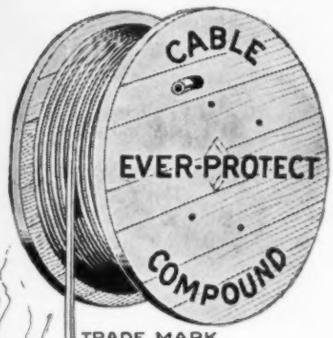




TRADE MARK

EVER-PROTECT offers the practical way for you to escape winter's ruin.

There's no guess-work about EVER-PROTECT cable compound enabling you to make a perfectly safe, durable and efficient installation of cable underground without conduit.

The testimony of practical telephone men and acknowledged telephone scientific authorities shows that an installation made with EVER-PROTECT cable compound gives you a job that is thrifty, water-proof, perfectly insulated and immune to chemical action and electrolysis.

Use of EVER-PROTECT is easy. All there is to its installation is shown in the border illustration. You need no expert help.

Pretty soon winter will be with you, with your overhead lines in ruin on the ground. It will be too late then for you to make your EVER-PROTECT installation underground. You'll be out a whole lot more money than it will cost you to use EVER-PROTECT NOW!

You risk too much by delay, and hundreds of successful telephone men who are using EVER-PROTECT will tell you there's not any risk in using EVER-PROTECT now.

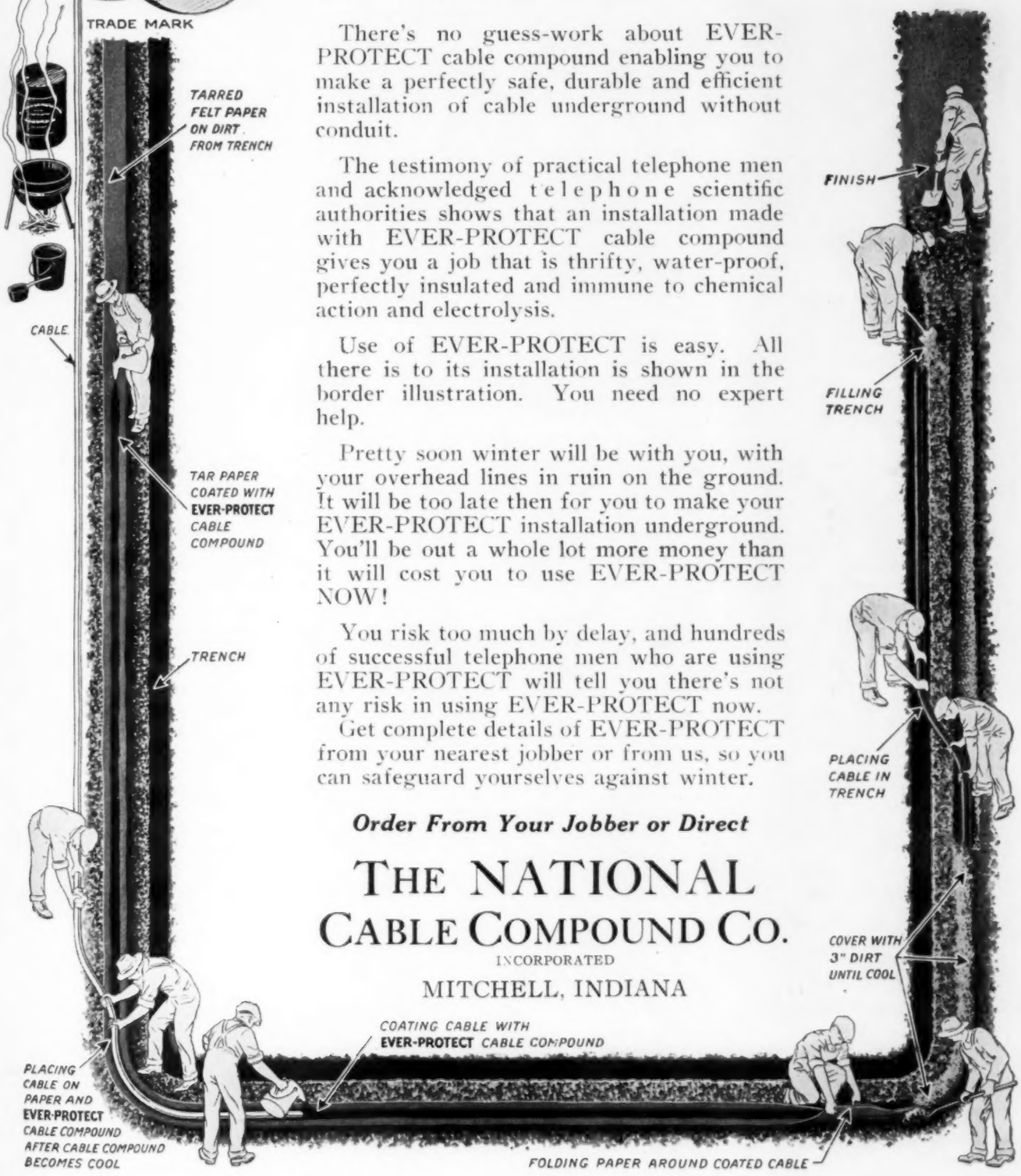
Get complete details of EVER-PROTECT from your nearest jobber or from us, so you can safeguard yourselves against winter.

Order From Your Jobber or Direct

THE NATIONAL CABLE COMPOUND CO.

INCORPORATED

MITCHELL, INDIANA


TARRED FELT PAPER ON DIRT FROM TRENCH
CABLE
TAR PAPER COATED WITH EVER-PROTECT CABLE COMPOUND
TRENCH
PLACING CABLE ON PAPER AND EVER-PROTECT CABLE COMPOUND AFTER CABLE COMPOUND BECOMES COOL
COATING CABLE WITH EVER-PROTECT CABLE COMPOUND
FOLDING PAPER AROUND COATED CABLE
COVER WITH 3" DIRT UNTIL COOL
PLACING CABLE IN TRENCH
FILLING TRENCH
FINISH

old pole. Some stray return current from interurban line.

Girard, Illinois. Cable in place several years. One location mixed black and clay soil. No corrosion in evidence on cable installed on repair job about one year previous. Second location mixed black and clay soil. Two repair sleeves in pit. Evidence of corrosion on old sheath. Stray return currents in some sections of plant but not in evidence where trouble occurred.

Conditions at Locations Not Inspected. Samples of soil and cable sheaths were submitted from various places by interested parties. The following descriptions were given by the parties furnishing the samples.

Washington, Ill. General conditions similar to Waynesville, Ill. Cable supposed to be pure lead. Corrosion found about 5 years after cable was installed. Information supplied by Mr. R. M. Matteson, Joliet, Ill.

El Paso, Ill. General conditions similar to other Illinois locations. 6,000 feet of cable installed about 1920. Supposed to be pure lead sheath. Trouble principally in 25 pair cable after three years. Information supplied by Mr. Harry B. Crandall, Springfield, Illinois.

Chatham, Ill. General conditions similar to Virden and Girard. Underground cable with pitch covering placed about 16 years ago. One case of trouble at point where pitch failed to cover cable and contact with concrete occurred. Sheath where pitch covering was intact was in perfect condition. Information supplied by Mr. F. A. Bowdle, Cerro Gordo, Ill.

Palacios, Tex. Cable placed in ground in 1920. Trouble occurred late in 1922. No street railways. Probably antimony-lead sheath. Information supplied by Mr. H. C. Inniss, Port Lavaca, Texas.

Wisner, Neb. Cable laid near ditch fed by spring water from nearby cattle-feeding lot. Cable badly decomposed forming white, flour like substance. No soil or cable samples secured in this case. 3,000 ft. of cable affected. Information supplied by Mr. J. W. Richmond, Wisner, Neb.

Minier, Ill. Conditions similar to Waynesville, Ill. (Distant 20 miles.) Considerable trouble due to deterioration of lead sheath. No sample of soil or sheath obtained. Information supplied by Mr. R. D. Crihfield, Minier, Ill.

Analysis of the soil samples obtained showed that most of the samples were basic and contained a considerable amount of organic matter. Tables are given in the bulletin showing the results of these analyses, and descriptions of some of the soil types encountered. Table 1, is taken from the bulletin to show the relation between corrosion of lead sheath and the soil type.

The presence of organic matter seems to be an important matter and drainage is another factor. The kind of lead used for sheath is another factor, the field observations indicating that tin-lead is the most resistant to corrosion. The presence of calcareous matter like limestone also has some influence on corrosion.

Laboratory Investigation.

An extensive laboratory investigation was made, the details of which are given in the bulletin but which can not be reproduced in this abstract. Many statements found in the literature of the subject were confirmed and some new facts were observed. The conclusions drawn from the field studies were verified and extended until a satisfactory understanding of most of the factors affecting the mechanism of lead cable sheath corrosion were reached.

Five different lines of investigation were carried out in the laboratory. The self corrosion of lead in contact with soil was studied at (1) room temperature and (2) at the temperature of an incubator. (3) The corrosive effect of acidity or alkalinity of water solutions on cable was observed. In addition (4) emf. and (5) metallographic studies were made of cable sheath corrosion. The results usually confirmed by two or more methods are given below:

1. Commercially pure sheath, under most conditions, is corroded less than antimony-lead but appreciably more than tin-lead.

2. The corrosion generally increases with the amount of organic matter in the soil; this is apparently caused by the corrosive acetic and similar acids formed from the organic matter in the soil.

3. Lime, limestone, cement or mortar aid in the corrosion of lead, promoting its oxidation and also by stimulating bacterial activity, which probably results in increased formation of corrosive acids.

4. Fragments of limestone, crystals of gypsum, etc., in contact with lead, hold moisture at the point of contact and hence aid corrosion. Iron rust appears to stimulate the corrosion of lead. Sodium chloride is quite corrosive. Cinders are also harmful.

5. The presence of moisture increases corrosion up to a certain point by forming hydroxide. Beyond this point water protects the lead by slowing up the approach of the oxygen necessary for corrosion.

6. In water solutions nitric acid, an oxidizing agent, is more corrosive than

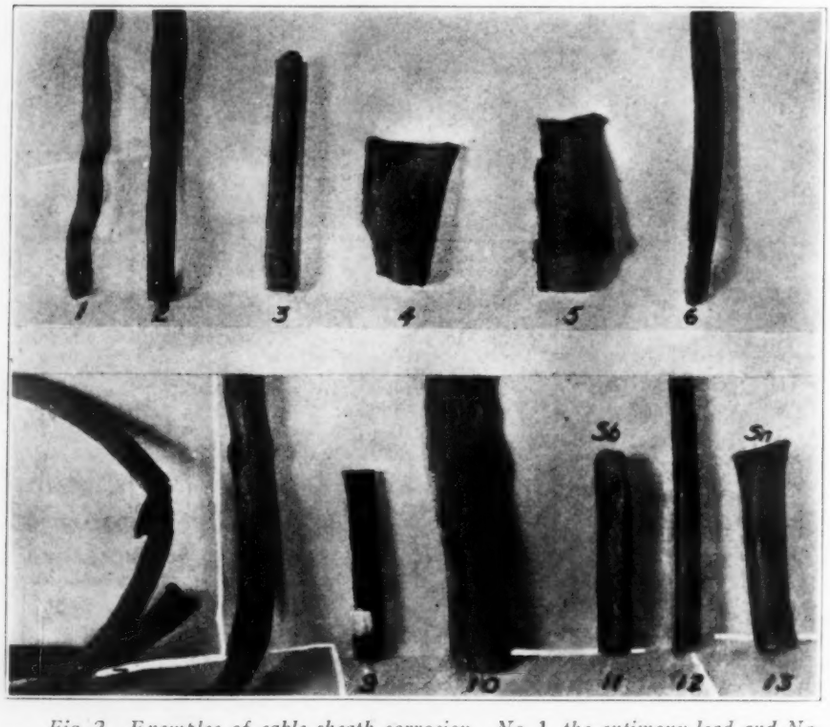
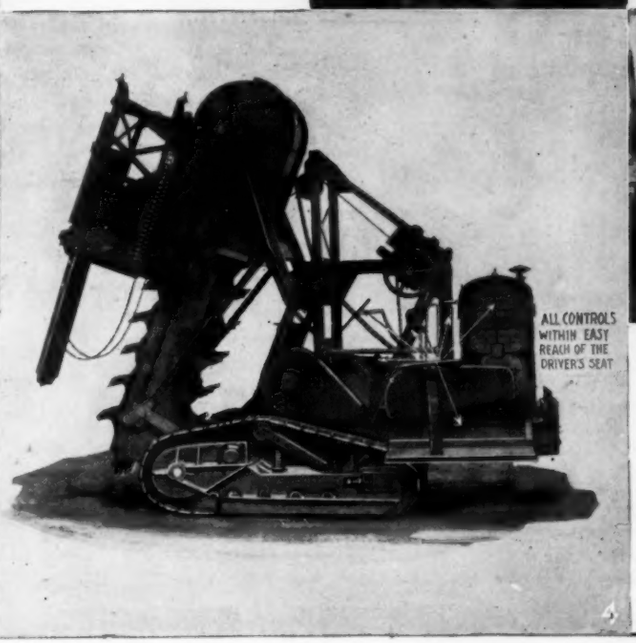


Fig. 2. Examples of cable sheath corrosion. No. 1, the antimony-lead and No. 2, the pure lead sheaths used in the laboratory tests. No. 3, pure lead from Washington, Ill.; No. 4, pure lead from Girard, Ill.; No. 5, 0.07% antimony from Macon, Ill.; No. 6, 0.74% antimony from Waynesville, Ill.; No. 6, antimony-lead from Wakarusa, Ind.; No. 8, an electrolytic corrosion from Wabash, Ind.; No. 9, antimony-lead from El Paso, Ill.; No. 10, 0.8% antimony-lead from Monon, Indiana, which lay side by side with No. 13, 4.5% tin-lead; No. 12, pure lead from Monon, Indiana.

1—*This Barber-Greene dug 680 feet of ditch 4 feet 3 inches deep in 11 hours, for the Champaign & Urbana Water Company, in Illinois.*

2—*Same ditcher as is shown in photograph No. 1. It worked in ground so wet that the ditch would be partially filled with water when the machine had passed.*

3—*A Wisconsin operator said: "When we strike a pipe underground, the overload release sprocket works, so that although we have struck a good number of pipes, we haven't broken a single one."*



4—*Showing many important improvements in the Barber-Greene Ditcher. As compact as last year's model, it has a greater capacity for hard work.*

5—*The Barber-Greene which saved the Western United Gas & Electric Company $884.11 in a month, digging 9,990 feet of trench.*

"The Darn Thing Is Almost Human"

"The darn thing is almost human," said a Kenosha, Wisconsin, operator about his Barber-Greene Ditcher. "It seems to know the difference between hard digging and what it should not dig up. When we strike a pipe underground, the overload release sprocket works, so that although we have struck a good number of pipes, we haven't broken a single one."

This was on a Wisconsin Telephone Company job. A second Barber-Greene was put to work, digging without difficulty through 6 inches of hard asphalt.

And every man that puts a Barber-Greene to the test, expresses the same surprise at its uncanny ability to dig in any kind of ground, to avoid cutting into pipes, to get around in tight places, and to dig up close to poles, curbs, trees and other obstructions.

Small, compact, powerfully built for constant gruelling use, it has three years of unfailing performance behind it. It digs straight down to a depth of 5 feet 6 inches, requiring no preliminary hand-digging, and leaving no sloping ramp. It is used successfully for digging post holes.

Self-cleaning buckets discharge the dirt positively, and a conveyor takes it to one side, piling it far enough away from the ditch to prevent its falling back. The discharge can be shifted from one side to the other. The Barber-Greene is self-propelled, mounted completely on crawler traction, and gets about quickly from job to job.

"Modern Ditch Digging" will give you the details of Barber-Greene performances in many different parts of the country. It explains how the overload release sprocket works, how it protects pipes, and how it will increase the efficiency of your digging. Send for it now.

BARBER-GREENE COMPANY—*Representatives in 50 cities*—660 West Park Avenue, Aurora, Ill.

BARBER GREENE

Portable Belt Conveyors — Self Feeding Bucket Loaders

Coal Loaders - - - - - Automatic Ditch Diggers - - - - Coal Feeders

acetic acid. Barium hydroxide is more corrosive than sodium hydroxide because of the greater coagulating effect of the divalent barium ion in precipitating lead hydroxide.

7. In the presence of soils, nitric acid forms yellow crystals of basic lead nitrite. Acetic acid forms lead acetate which is very readily hydrolyzed to set the acetic acid free again. Hence, acetic acid acts catalytically to produce a pit in the sheath.

8. Some experiments on the so-called allotropy of lead indicate that the effects observed are corrosion products.

9. Corrosion is intercrystalline at first, followed in pure lead and antimony-lead by attack over the whole surface with occasional pitting. In tin-lead further corrosion is almost wholly intercrystalline.

10. Tin increases the resistance of lead to corrosion because of the corrosion resistance of tin itself, because of the ease of solution in lead to form a corrosion withstanding solid solution and because of the proximity of the two metals in the e.m.f. series.

11. Antimony added to lead decreases its resistance to corrosion because the solubility of antimony in the lead crystals is too little to counterbalance the presence between the crystals of considerable amounts of antimony which, being well removed from lead in the e.m.f. series, promote local galvanic action.

12. Pure lead exhibits a laminated crystalline structure. The number of crystals showing this structure as well as the regularity of the laminations decrease with the addition of impurity. The attack on pure lead crystals consists in dissolving off layer after layer.

Prevention of Self-Corrosion in Soil.

The present study indicates that any cable sheath laid directly in any soil is likely to be subjected to corrosion. In one case at Monon, a sample of tin-lead sheath which was apparently unaffected by corrosion when viewed by the naked eye, showed a network of corrosion when viewed under the microscope. (Fig. 3.) The conclusion must be reached that buried cable must be regarded as a type of construction that has a definite wearing life just as wooden poles have a definite wearing life. In some soils this is likely to be very long while in other soils the experience of many companies indicates that it is rather short. One company which has employed a considerable amount of this type of construction is now figuring that the life will be ten years.

The absence of corrosion in ordinary construction where clay duct is used as conduit, is explained by the fact that the clay tile gives an effective separation between cable sheath and the soil. Even if the duct is filled with water, the continual change of the water does not ordinarily allow chemical action to take place although a few cases where this has occurred are known. Taking all of these facts into account, the conclusion must be reached that the only means for preventing corrosion of lead cable sheath is to prevent contact between it and the soil.

Fig. 3. Photo-micrograph of tin-lead sheath after contact with earth, X35. The same sheath as No. VC *in Fig. 2. Although apparently free from corrosion to the naked eye, a network of corrosion product is observed with the aid of the microscope.*

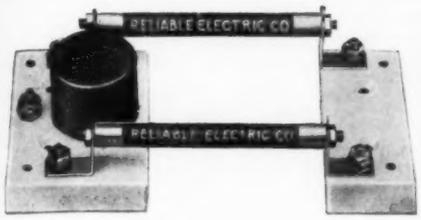
Use of Protective Covering. The use of protective covering of cable buried directly in the earth has been the subject of extensive discussion. Among the coverings that have been suggested or used are a thin covering of sand, wooden strips, building paper, crushed limestone, concrete slabs, etc. Most of the companies using buried cable have abandoned the use of these protective means as they have felt that the benefit derived from them was not sufficient to justify the added cost. Recently a compound has been placed on the market which has found a wide sale. This compound is apparently a pitch of asphaltic substance which has good properties of adhering to the cable. Its exact composition is not known but it is probably quite complex from a chemical standpoint. As far as known this type of compound does not contain anything that would be injurious to the cable sheath. Similar compounds have been used for

(Continued on page 40)

TABLE I.—THE CORROSION OF LEAD CABLE SHEATH WITH REFERENCE TO COMPOSITION OF LEAD AND TO THE SOIL TYPE.

Place.	No.	Reaction to ferric thio-cyanate.	Kind of Pb.	Degree of Cor-rosion.	Description of the Soil.	Drain-age.
INDIANA						
Monon .....top	1A	basic	pure	bad	Clyde loam with $CaCO_3$ from street surface	Fair
sub	1A	"	"	"	"	"
top	1B	"	"	slight	Newton loam with $CaCO_3$ from street surface	"
sub	1B	"	"	"	"	"
	2	"	Sb 0.8% Sn 4%	bad v. little	As 1A	"
top	3	"	Sn	almost	As 1A, but more org.	"
sub	3		3.1%	none	matter	"
Lapel	1	basic	Sb 0.8%	bad	Crosby silt loam	"
top	2	acid	"	"	"	"
sub	3	basic	"	"	"	"
cinders	4	acid	"	v. bad	" with cinders	"
Wakarusa		basic	"	"	Clyde or Miami loam	"
Wabash	N	basic	"	None	Shallow yellow clay above limestone rock. Little organic	Good
	S	"		"		
ILLINOIS						
Waynesville	1	acid	Sb 0.74%	cor.	Dark gray loam surface	Fair
	2	basic	"	Bl. Dep. on cable	Glacial till sub soil	Poor
	3	"	"	v. bad		Fair
Virden*	1	acid		v. bad	Black clay loam	Fair
	2	"	No	"	Cinders. Black clay loam Glacial till below	"
	3	"	sample	bad		Good
Girard	1	acid	pure	bad	Same as Virden	Bad
	2	"	"	"	Same as Virden	"
Macon .....top	1	basic	Sb 0.7%	bad underside	Black clay loam	Bad
sub	1	"			Black clay loam mixed with calcareous till	"
top	2	acid	"	bad in spots	Same as No. 1 with some cinders	
sub	2	basic	"	"	Same as above	"
	3	acid	"	none	Black clay loam	Very good
Washington		basic	pure	bad	W ⅓ light gray silt loam E ⅔ brown silt loam Calcareous till below	
El Paso.....		basic	Sb 0.3%	bad	Much like Virden.—sample black loam and calcareous till mixed	
Chatham		acid	pure	protected	Brown to gray silt loam, sub soil calcareous	
TEXAS						
Palacios		basic		bad	Calcareous (shells) dark Victoria soils	

*In Virden and Gerard No. 2 a trolley line parallels the cable and true electrolysis was proved by the voltmeter tests. However, the conditions are favorable for chemical or self-corrosion also, so that the results observed are probably due to both effects.



977HH Arrester
APPROVED

P495
Discharge Block

Underwriters approve Self Cleaning Discharge Blocks mounted in many standard types of protectors.

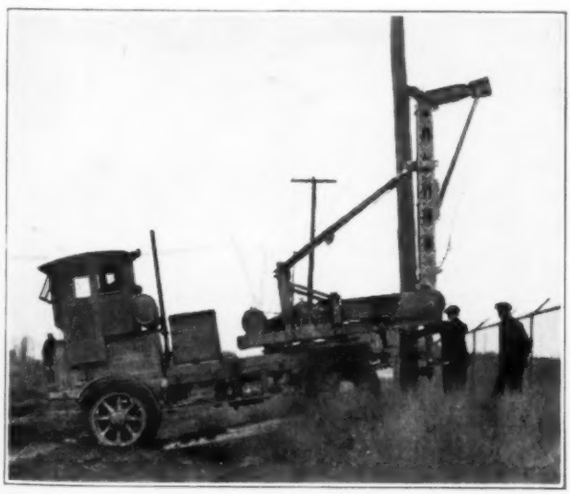
Reliable Electric Company

3145 CARROLL AVENUE CHICAGO, U. S. A.

Earth Borer and FWD Truck Make Efficient Telephone Device

Clintonville, Wis.—A further advance in telephone line construction equipment is registered by the new FWD earth boring machine, a mechanical pole hole boring device mounted on a four-wheel drive truck. The device is made by the Four Wheel Drive Auto Company, of Clintonville.

The accompanying picture shows the FWD earth boring machine in operation. This machine digs holes from 6 inches up to 4 feet wide and as deep as seven feet, depending on the size of the hole. The time required for digging the hole varies from 1½ minutes to 10 minutes, depending on the condition and nature of the soil. (A report just received from the Ohio Bell Telephone Company, which is operating a machine out of Youngstown, Ohio, reads to the effect that at places where there was no frost, shale or rock they dug 18-inch holes 6 feet deep on an average of 1½ minutes each.) The standard size augers used are 18-inch, 20-inch, 24-inch, 30-inch and 48-inch. The 48-inch auger is used for digging the holes for abutments used in the construction of high power lines.



A FWD Earth Borer on the Job.

Thirty-five-foot poles can be set with the standard machine which is rated as a 6-foot size. Poles up to 70 feet can be set with what is called the 9-foot size machine and has a special derrick and longer tower. The machine also pulls the old poles.

The power for operating the earth boring machine is supplied from the truck engine by means of a power take-off shaft at rear end of transmission.

The frame of the earth boring machine is rotatably arranged on a turntable, which makes it possible to bore holes on either side or rear of the truck. A locking device holds the frame with the auger in position. The turntable is operated by power, and it requires but 15 seconds to turn it from one extreme position to the other.

For boring anchor holes the tower is tilted with a worm gear into any desired angle. In transport the auger tower is tilted toward the driver's seat.

This machine digs the hole in any kind of soil that can be dug by hand methods without blasting, raises the pole and drops it into place.

A detachable derrick is provided for handling long poles. The sheave on derrick is 38 feet from ground and can be quickly set up or taken down. The derrick is carried on side of truck and projects 6 feet 4 inches behind rear of machine when assembled for transportation. Overall length of chassis with derrick folded is 28 feet.

(Continued from page 38)

sealing potheads for many years without trouble. If the compound is coated over the cable in a way that will prevent direct contact between the sheath and the soil, it is probable that it will prevent corrosion of the types found in this investigation.

A sample of cable sheath was received from Chatham, Ill., which was laid in a pitch covering (Fig. 4b) about 16 years ago and no discernable deterioration had taken place where the covering was perfect. In one place

Fig. 4a. Concrete in contact with lead heath has completely corroded away the metallic lead which is seen as white lead forming the lighter parts of the samples.

where the pitch did not prevent contact between the sheath and the concrete (Fig. 4a), the cable was badly corroded. Whether this was due to self corrosion or to electrolysis was not determined. This case illustrates the difficulty that may be expected from any covering of the asphaltic type unless special precautions are taken to insure a complete encasement of the cable. No information as to the cost of this covering was obtained but it is understood that the cost is relatively low.

It has been found by some investigators that protective coatings of

Fig. 4b. Pieces of asphalt protecting coating removed after 16 years of successful service at Chatham, Ill.

carbonates, silicates or phosphates have been formed on lead water pipes which prevent further corrosion. As far as known, no method of applying protective coatings of this type have been developed, but there may be possibilities.

General Summary and Conclusions

The present study of the corrosion of lead cable sheath when placed in contact with soil, covered two series of investigations; one in the field and one in the laboratory. In general, the results of the two investigations were in agreement. A good understanding of the causes and conditions for corrosion were obtained and an accelerated test was developed which would give a good indication of the amount of corrosion likely to occur in a given soil with a given example of sheath material.

Causes of Corrosion. In general the most important cause of corrosion is the presence of organic matter in the soil. Decomposition of the organic matter produces acids that tend to attack the material of the cable sheath. Corrosion product was obtained from about 80% of the cables inspected and in nearly every case tests for acetic acid were obtained. Decaying wood and vegetable matter produces this acid and, hence, it is inadvisable to use untreated wood boards as a protection for the cable.

Alkali in the form of limestone, concrete, gypsum, etc., also is a direct cause of corrosion in some cases, and in all cases is likely to increase the corrosion rate. Salts, particularly common salt, may also be a cause of corrosion due to local galvanic action.

Factors Which Increase Rate of Corrosion.—In general, the rate at which corrosion takes place increases with the amount of organic matter in the soil. This conclusion was supported both by field and laboratory observations. In the laboratory, the order was found to be (1) muck, (2) cinders, (3) sand, (4) clay. Corrosion is likely to take place more rapidly in soils containing limestone and other calcareous matter, or where cinders are present. It is more rapid in poorly drained soils than in places where the drainage is good.

Effect of Sheath Compositions.—Both field and laboratory data indicate that tin-lead alloy sheath is much more resistant to corrosion than pure lead. Antimony-lead alloy on the other hand is less resistant to corrosion than is pure lead. This seems to be due to the fact that the corrosion starts in the intercrystalline spaces. The greater part of the antimony appears between the crystals while the greater part of the tin goes into a solid solution. Tin is naturally more resistant to corrosion and is so near to lead in the e.m.f. series that very little local action is likely. Antimony lies further from lead in the e.m.f. series and more local action is likely.

Prevention of Corrosion.—The only means of preventing corrosion is by separation of the cable sheath from the soil. In the construction using conduit this is done effectively by the clay duct, which accounts for the almost complete absence of corrosion. A limited experience with pitch or asphaltic coverings indicates that corrosion will be prevented if the covering can be complete and continuous. The use of concrete, limestone or untreated wood in direct contact or in the vicinity of the sheath should be avoided.

An extensive bibliography of the subject is given in the concluding section of the bulletin.

Spain Makes First Deal For American Operation

New York, N. Y.—Confirmation of press dispatches has been given out by the International Telephone and Telegraph corporation that the king of Spain has signed the decree authorizing the execution of a contract already approved by the military directorate with the Compania Telefonica Nacional de Espana, which was organized by the International Telephone and Telegraph corporation in co-operation with leading Spanish banks for construction and operation of a general telephone system throughout the entire Spanish kingdom.

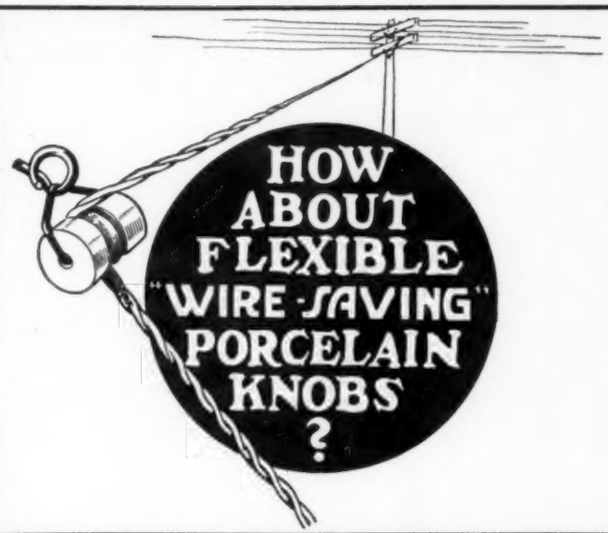
The new company, which will take over and consolidate the existing government-owned telephone system with the systems of the principal private concessionaires, which it already has under option, is a Spanish corporation. It proposes, not only to finance its operation very largely with Spanish capital, but also to encourage the fullest development of the manufacture of telephone equipment in Spain.

The International Telephone and Telegraph Corporation of New York, besides its financial interest, will act as the technical and financial adviser of the new company in connection with the extensive program of expansion and development, which will be announced in due course of time.

The new contract of the International's Spanish subsidiary is particularly interesting, as it is the first European telephone system to be taken over for operation and extension by the American company. The company, it is understood, has been in negotiation with the Italian government for a similar contract.

Incidentally, Spain is the first European country to permit a government-owned system to get under private management along the lines of the American telephone systems. The International, with its experience in Cuba, is considered well adapted to develop the Spanish telephone system.

In 1922 Spain had only 82,500 telephones in use.



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Southern California Plans Three New Plants

Los Angeles, Cal.—The Southern California Telephone Company is shortly to start the erection of three new telephone switching building prospects, the combined cost of which will be $2,640,000, according to an announcement by N. R. Powley, commercial superintendent.

Two of the projects are for the Wilshire-Hollywood district and the third is to supplement Garfield office in the Garvanza district.

The new buildings are part of the company's construction program which will cost more than $20,000,000 this year, and which embraces only the close-in sections of Los Angeles and nearby territory.

Powley said these three new buildings are engineered for an ultimate capacity of 210,000 telephones, or as many as were in the entire city less than a year ago. That is, there will be room for enough equipment to serve a total of 90,000 telephones as the buildings will originally be constructed, and the plans make it possible for enlargement to serve 210,000 telephones.

Hanover, Kan.—The Hanover Telephone Co., belonging to A. F. Geyer, has been purchased by D. H. Thomas, of Washington, and his brothers at Waterville.

Requirements for telephone equipment increased three-fold from 1919 to 1924.

An average of over 2,800 telephones were added every working day during 1923 to the telephone systems in the United States.

Illinois District to Meet at Canton Sept. 17

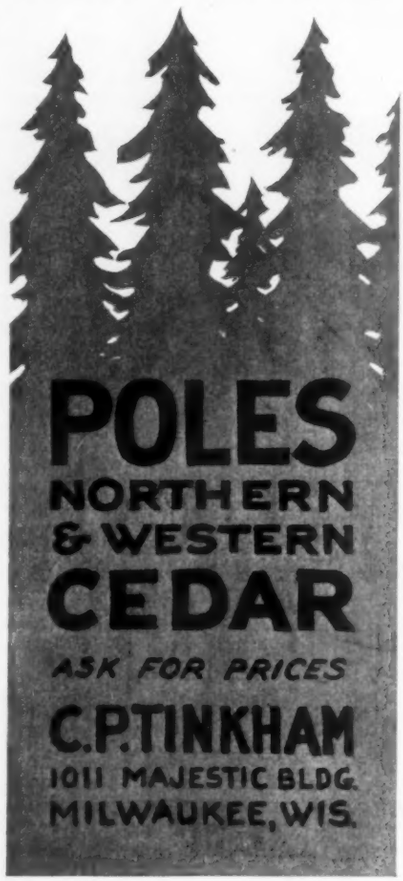
Canton, Ill.—The September district meeting of the Illinois Telephone association will be held here September 17. Executive conferences will be held at the Country Club, and the operators' sessions, which will be conducted by Miss Katherine Norris, will be held at the Elk's Club, according to the tentative plans announced by the association's secretary, Jay G. Mitchell.

TO REMOVE WOOD BRACKETS WITHOUT INJURY

Linemen know what a task it is to remove wood brackets from a pole and how nearly impossible it is to remove them without ruining the bracket, even with a wrecking bar or nail puller. If you will take a hack saw and cut the nails between the pole and the bracket they can be removed without injury and with very little effort.

This may be an old trick to many, but I believe there are some like myself who never thought of it, so I pass it along. Ray Blain, Telephone Plant Engineer, Omaha, Neb.

Despite the immense amount of telephone wire now laid in underground cables, there are over 15,000,000 telephone poles in the United States or an average of approximately one pole for every telephone.



Engineer Invents New Call Register

A new registering apparatus to be used in connection with a telephone set has been invented by Benedetto Sapienza. The device requires no change in the wiring of the telephone set. A battery energizes the recorder. Calls made in absence of attendant at subscribing station are registered, so, according to the inventor the subscriber may learn from the central station the numbers of those who called while the receiving station was unattended.

This device is a great improvement for telephone use and makes it possible for companies to make extra charges on these special calls. Write for details.

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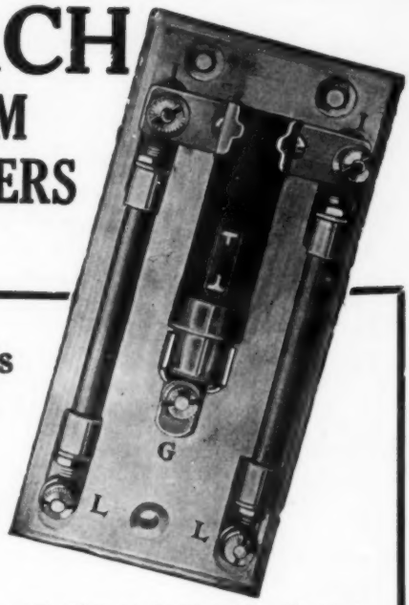

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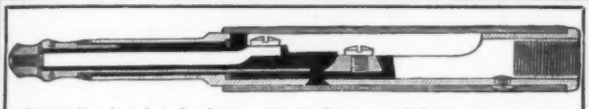

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Jiggle the Hook—You're Out of Luck in Paree

Paris, France—An ingenious administration has decided to add yet another trial to the many already borne with humble resignation by Parisian telephone subscribers, states the London **Daily Telegraph's** Paris correspondent. In future, when a subscriber calls the exchange, a number will appear over his disk on the operator's board to indicate his turn in the waiting list. As each appeal is answered, the subscriber who started twelfth in order will gradually move nearer to number one, but should he, in protest against delay, tap the hook, the number of his turn will automatically disappear, and he will have to begin again at the end of the waiting list.

All the gold mines in the world put together did not produce enough gold last year to pay for the telephone construction and replacement being done during 1924 by the telephone companies in the United States.

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Wetumka, Okla.—C. P. Hicks sold the Wetumka Telephone Exchange the first of September to James Thompson and James A. Schooler, of Sand Springs.

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Southern California Phone Co. Plans Three New Buildings

Los Angeles, Cal.—The Southern California Telephone Company plans to build three telephone switching buildings, to cost with initial equipment more than $2,640,000. These are among the most important projects in the company's $20,000,000 construction program this year for the Los Angeles district.

Up-State New York to Meet, Penn Yan, September 26

Albany, N. Y.—A district meeting and traffic conference of the Up-State New York Telephone Association is to be held at the Benham Hotel, Penn Yan, Yates county, New York, September 26.

The telephone companies in the United States have invested in telephone plant a sum equal to more than half the value of all the monetary gold in the vaults of the United States Treasury and of the Federal Reserve System put together.